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The Chemical Industry in 1932

THE year which draws to a close to-day will go down in history as one of the most critical periods in the annals of this country, and therefore also of the chemical industry, which touches the national life at so many points. It has been a black year for nearly every class of industry, but there is increasing evidence that the worst is over, and even if we are not yet out of the wood there is every reason to hope that 1933 may see an upward trend. The leaders of the chemical industry perceive a glimmering of the dawn as regards the trade of this country, and they have reason to be confident.

The Board of Trade returns relating to overseas chemical trade show that for the eleven months to November 30, the imports of chemical products amounted to £8,702,987, against £12,617,103 in the same period of 1931 and £12,430,903 in the first eleven months of 1930. Chemical exports for the same period rose slightly to £15,899,530, compared with £15,720,763 in 1931, but they still fell disappointingly short of the £20,447,167 recorded for the eleven months of 1930. There is genuine satisfaction to be found, however, in the fact that the adverse balance has been considerably narrowed, notwithstanding that the new tariff system did not become operative until March 1.

It is unnecessary here to enlarge upon the importance which the chemical industry attached to the Imperial Economic Conference at Ottawa in July, for the subject is dealt with elsewhere by Dr. E. F. Armstrong, whose proposal at the annual meeting of the Association of British Chemical Manufacturers to establish a group sales organisation to enter the Canadian and other Dominion markets was one of the big news events of the year. There is no doubt that Ottawa and its consequences will have far-reaching effects upon the chemical industry in the future.

Without enumerating the causes, including the payment of war debts, which are aggravating the situation, Dr. Armstrong points out that it is at least clear that for a country like Britain, which has necessarily left the gold standard, it is becoming an impossible strain to acquire dollars or francs in sufficient quantity for us to trade with the United States or France, and that our only hope is to create a section of the world sufficiently large in size and population which will be on a sterling basis, and which will contain the necessary raw materials and manufacturing capacity, to enable its population to satisfy all its demands. The importance of Ottawa when it is seen from this angle becomes obvious—given freedom of trade within the Empire, with the absolute minimum of protective tariffs and the abolition of the tariff on Empire goods as a means of collecting revenue, as well as the

abandonment of the vexatious customs of administration, there will be no obstacle in the way of each and every part of the Empire building up a trade with any other part of it.

Restricted trading conditions during 1932 have not encouraged bold enterprise in the solvents industry, which has, in consequence, tended to adhere to established practice. A good deal of experimental work, however, has been carried out during the year, and many new processes have been evolved, but these, arising in an apathetic atmosphere, have failed to arouse sufficient interest to be given an extended practical trial. There have been attempts to extend the use of lacquers in hitherto undeveloped fields, more particularly for interior and exterior house decoration. Along these lines the industry has had to consider the disadvantages of spraying lacquers for interior work and the consequent need for improved brushing lacquers, and, in the case of exterior work, the difficulties associated with the poor adherence of cellulose lacquers on wood exposed to weather changes. Some progress, however, has been made, though the methods evolved have not had very extensive practical trial.

New methods of synthesising alcohol to meet the possible new demand have aroused considerable interest. The Chemical Research Laboratory at Teddington has investigated the synthesis of alcohol from carbon monoxide and hydrogen and has so far obtained only moderate success. Any process will be handicapped if it produces appreciable amounts of by-products, since a market will have to be found for large quantities of these, and this is probably the chief disadvantage of the CO and H₂ synthesis. A large number of investigators are working on the synthesis from ethylene, which can be obtained in almost unlimited quantities by cracking petroleum.

From the review of the nitrogen industry by Dr. E. B. Maxted, which appears in other pages, it will be seen that, while the number of papers and patents in this field which have appeared during 1932 may possibly be somewhat less than in previous years, the ground covered by these is more or less normal. No outstanding new trend of work has appeared during the year. Indeed, nitrogen fixation and its attendant processes have become standardised and the absence of a large number of proposed improvements is an indication of the technical stability of the methods now adopted. The progress of manufacture and of original work in the nitrogen field has necessarily been affected by the prevailing conditions. While the potential market for fixed nitrogen, given normal times and adequate education of possible nitrogen buyers, cannot be regarded as being by any means fully covered even

by the huge existing nitrogen fixation plants, the nitrogen problem has become rather the finding of markets for available supplies than the further development and extension of the industry.

The increasing importance of the plastics industry led to the formation during the year of the Plastics Group of the Society of Chemical Industry, under the chairmanship of Mr. H. V. Potter, to cater for the purely chemical interests of this new industry. It has been estimated that the plastics industry represents a tonnage production of 25,000 tons per annum, not counting the moulding industry, whose function is to convert plastic materials into finished articles. The number of patents granted in this country in 1932 covering the manufacture or application of plastics is in the region of 300, thus representing about $1\frac{1}{2}$ per cent. of the total number of patents granted. This new industry has found its feet by the skill and perseverance of the chemist, engineer, technician and man of commerce as far as the manufacture of plastic materials is concerned, and it will do well to call in the sympathy and understanding of the experts in the application of the finished products in order that the future of the industry may be assured.

Investigations of chemical interest have been carried out as usual at the various stations of the Department of Scientific and Industrial Research, a review of whose activities gives the reader some idea of the extent of the influence exercised by the Department. Chemical investigations of considerable importance have also been included in the programmes of many of the research associations formed under the scheme of the Department. The principal studies of the Department have been concerned with canning research, corrosion problems, polished nickel coatings, synthetic resins, high pressure chemistry, the constitution of tars, hydrogenation, water pollution, building materials, cellulose and the operations of the Fuel Research Station at East Greenwich.

The chemical division of the British Standards Institution, which was formed a little over a year ago, with the active co-operation of the Association of British Chemical Manufacturers and other organisations in the chemical industry, has had a period of considerable activity and has set up a number of small committees to deal with different classes and groups of chemical products. While this valuable work has been proceeding, the Institution has not neglected its standardisation activities in the sphere of chemical engineering, which were already in hand before the chemical division was officially constituted. A number of new specifications have made their appearance during the past twelve months, and a considerable amount of interesting work is in hand, including the standardisation of sieves and screens for industrial purposes, metal, earthenware and glass containers for heavy acids, corrosives and solvents and welded containers for liquefiable gases.

It is reported that the hope expressed a year ago that the home market for synthetic fertilisers has been more than justified, and there is increasing evidence that with some kind of Government intervention in agricultural affairs the world over, the industry will continue as a main plank in the structure of the British chemical industry. As reported elsewhere, the world production figures for synthetic and by-product nitro-

gen reveal that stocks have been allowed to decline by some 150,000 metric tons of nitrogen. This decrease is reflected proportionately in all types of nitrogen fertilisers with the exception of Chilean nitrate, stocks of which have probably increased by at least some 140,000 tons of product, a figure suggesting either that production has not yet sufficiently reduced or that there is a marked diminution in sales. The outstanding feature of the sulphate of ammonia market was an increase of no less than 37.6 per cent. in home consumption in a single year. Except for the war years 1917 to 1919 the tonnage consumed, namely, 228,338 tons, has never before been reached. This sudden leap in consumption is attributed by the industry to a combination of two factors, education and price reduction, with the latter vastly in excess of the former. The low price of sulphate of ammonia for agricultural use which ruled for some months has resulted in a national swing-over at the expense of other popular but higher priced nitrogen fertilisers.

We are told that the only country in which construction of chemical plants on any substantial scale is taking place is Soviet Russia, where many factories have been built or are being built under the Five Year Plan. The year has not, however, been entirely without interest from the point of view of the development of chemical engineering in this country, and Dr. A. J. V. Underwood enumerates in his survey of the year's progress many noteworthy achievements in the way of new plant and equipment. A point to be borne in mind is that in times of economic depression the far-seeing manufacturer buys such plant as he will require in the future, knowing that when metal prices are low and there is cut-throat competition to obtain his orders he can secure his plant at prices which will be impracticable when normal conditions return. Moreover he will be ready to take advantage of any improvement in trade while his competitor, having carried his policy of caution and economy to extreme limits, will start to buy his plant at higher prices and to wait for delivery of it.

On the financial side, there are many indications that the bottom of the depression has been reached, and that British industry as a whole has successfully weathered the storm. In other pages, Mr. S. Howard Withey, senior fellow of the International Accountants' Corporation, analyses the financial position of the chemical industry, as represented by a number of undertakings in different spheres of chemical production and plant manufacture, from which the conclusion is inevitably drawn that the industry is financially sound and adequately prepared for the turn of the industrial tide.

To-day, as the chairman of the Association of British Chemical Manufacturers writes elsewhere in this issue, the chemical industry is strong in itself, both technically and financially, efficient and energetic in its organisation. The spirit of co-operation is more than ever alive, and the changes which have been effected in the fiscal system during the past twelve months assure the industry the necessary protection against countries with a lower standard of living and labour costs. The markets of the Empire, with a potential trade of upwards of £20,000,000, are within its orbit, and with the necessary display of resolute energy the possibilities of extension are distinctly favourable.

Some Thoughts on 1932

By Professor H. E. ARMSTRONG

PERHAPS a peak year! At least, near to a turning point. One of general world crisis, in which individual units in our social economy have been forced to admit the need of re-adjustments, favouring co-ordination and fusion of interests, in every field of activity—in none more than our own.

Nominally, the prime difficulty, in the world, at the moment, is gold. The nations are quarrelling together over its mal-distribution. The chemist knows everything about it, except how to use it. In this he shares the general ignorance. Gold after all is but a material symbol—a substance beautiful in itself, yet artificially elevated, by agreement, into the god-like position of a standard of exchange. Everyone is affected by the dearth; almost everyone understands the situation, more or less. What we do not recognise is that, behind gold, there is something, that does not glitter, far more important. The great hidden force at work in the world, the one real medium of exchange, is intelligence! We take no notice of our shortness of this medium—of its mal-distribution; nor do we mine for it with intent. We have no recognised cyanide process for its extraction from weak ore. Such digging as we do is too often by thoughtless if not incompetent hands. This perhaps is the greatest discovery towards which we have been moving during the year; the one which most concerns us.

Extracting Intelligence

Having taught the world how to extract gold, surely it is the duty of the chemist at least to make the attempt to discover for it the method of extracting intelligence. Chemistry is the science of worldly substance and substantial change. Being such, it is the root science and its method must be a root method. Its method is the art of calculated, experimental inquiry, with all the consequences that flow from a practice proved to be of infinite power. We need to teach all, at least, to have inklings of this art; to teach it in schools, in immediate association with the three R's, as a means of discovering intelligence and bringing it to the surface for public use. No production of a new substance is called for; no fresh entry in *Beilstein*. What is called for is the application of a discipline—the creation of a mental state—the cultivation of eyes that see and reason—of an informed and proportionate judgment.

The year is one in which the hope has been strengthened that, ere long, we shall be able to take command of ourselves in matters of health; when we shall be able to say: "Get thee behind me, Physician, go cure thyself!" The time should be near when the medicine man will be less concerned with curing disease than in preventing its occurrence—when he will sufficiently understand the chemistry of life to be able to counter all attempts to subvert the proper action of our human mechanism. It is a disgrace to the chemical profession that ignorance of so much that is fundamental in chemistry should prevail in the medical profession to-day. The fault is ours—we should long since have mutinied against the unsatisfactory foundations laid in the schools and the conditions under which we are forced to teach medical students, knowing them to be wrong. Medicine, apart from surgery, is but applied chemistry. It should not be a study of drugs but mainly of foods and feeding.

The Human Body a Great Factory

We are clearly on the way to establish a food conscience. The net of knowledge is being more and more closely drawn; we can see that it not only has many fish in it but a great variety. The human body is not a mere machine but a great factory, housing a great number of different machines, which are or can all be geared together, to work together at call from a central signal cabin. Each seems to need—alternatively, to produce—not a single "Amy-advertised" Castrol but its own special lubricant. At present, we can give no better name—we are so entirely ignorant of the special functions of the various glandular secretions and natural "condiments." I have long urged that they should all be classed together as *advitants*, whether mineral or organic, of endocrine or vegetable origin. Experience has taught me to value non-committal names of general application. I early learnt the lesson from the late professor Alexander

Williamson of ether fame. *Urea* is a good illustration of a perfect name; *carbamide* may be an alias which it sometimes wears but not a description of "its usual self."

The influence of specific food constituents upon special functions is brought out in a remarkable manner in the case of the bee. The Queen Bee has extraordinary powers of fertility; she is regularly fed upon a special food, known as "Royal Jelly." Sir Leonard Hill and E. F. Burdett have recently carried out experiments with female rats fed upon a diet free from the "factor-of-fecundity," contrasting the effects of additions of "Royal Jelly" and of the honey and pollen food given to the bee workers. In several cases, the rats have been rendered fertile by the "Royal Jelly." The magic influence of orange juice upon scurvy is well known.

Our Service to Humanity

Our chemical knowledge of these matters is growing apace, though shadowy and fragmentary in large part. English workers are well to the fore. Unfortunately, there has been too much premature publication, in the race for priority, if not for patents. As chemistry appears to me at the moment, the vision it presents is one of infinite service to humanity. On this account, it is undesirable that patents should be taken out in this field. There should be an honourable understanding to such an end among the nations. The workers are usually, if not always, in receipt of public funds.

The work is partly chemical and partly physiological. On this latter side, not infrequently, there is much left to be desired. The wish to detect some special agent may easily be father to the thought; over-emphasis may easily be laid upon the great part played by this or that individual agent and the need of a general balance overlooked. This is beyond question true of plant growth; much agricultural experimenting is vitiated by the failure of the workers to consider this need.

The most hopeful observations are those Sir Frederick Keeble has described in his recent book on "Fertilisers," showing that it is possible to obtain milk of summer quality, during the winter, by feeding cows on specially fertilised grass, cut young and dried during the summer. The improvement is due to the use of nitrogenous fertilisers, together with a complete mineral treatment and proper cultivation. The results were fully confirmed by chemical examination, by Professors Drummond and Heilbron. If I mistake not, this work constitutes an epoch in itself, in the possibilities it foreshadows and its far-reaching industrial value.

The Vast Field of Food Study

The field thus opened out for study by competent chemists is a vast one. Putting some imagination into the purse of farming, I can dream of a future in which it will be a *great organised industry*, under general scientific control in all its branches, carried on not as an individual occupation but with invested capital, like any other industry.

The primary objective would be an *ideal milk*—this, in fact, should be the fulcrum of the industry. In our dreams, some of us are already persuaded that, if all were properly fed, children especially, if we had *ideal food*, disease would lose its terrors; cancer and tuberculosis might disappear. Apart from fruit, we should be able to feed ourselves upon home-grown produce of an ideal quality. The supposed virgin soils of the new countries have been raped throughout time by animals and the rains; the foods grown upon them are, beyond question, not what ours might be, if fully fertilised. A colossal work is before the chemist, if we are to accomplish this end.

Natural Synthesis of Urea

To him who waits all things may come. Urea was first produced artificially in 1828, by Wöhler. In 1868, I witnessed Basarow's experiments in which he prepared it by heating ammonium carbamate under pressure, the process by which it is now manufactured industrially. We have long known that it is formed in the liver—the process has only recently been disclosed. It is built up, as it were, upon a compositor's stick, much as bricks are piled into a bricklayer's hod. The stick or hod is the diaminovaleric acid, *ornithine*, $\text{NH}_2\text{CH}_2\text{CH}_2\text{CH}_2(\text{NH}_2)\text{COOH}$, acting maybe under the

influence of the enzyme *arginase*—perhaps itself an ornithine derivative. With the aid of carbamic acid, the terminal NH₂ group is first converted into the group NH(CO.NH₂), then by the action of ammonia into the complex uramido-group, NH.C(NH).NH₂: the elements of the urea molecule are thus built upon and into the ornithine molecule, converting it into *arginine*. Finally under the influence of arginase, this last is resolved into ornithine and urea; the former returns to the fray to act as a catalyst, whilst the latter is voided through the kidneys. A wonderful concerto in three movements, no more perfect composition is to be found in our albums of chemical music.

Another of my earliest recollections is O'Sullivan's classical (1876) study of the action of malt diastase upon starch. Generations of exact muddlers have striven in vain to unravel the mystery of the brewers' mash tun but the sole result of the work on starch has been to increase the confusion. To those of us who have studied the enzymes, it has long been obvious that diastase itself must be a composite material. I have often urged my friends to separate its constituents and ascertain their individual effects upon starch. At last, this has been done. An α - and a β -amylase have been separated, which act differently upon starch, the one producing the α -form of maltose, the other the β -form. These are produced in different proportions. The explanation put forward is, that natural starch contains two starches, corresponding to the two varieties of maltose. Animal diastase is said to consist only of α -amylase. We may hope that these observations will be extended and confirmed, without loss of time, so that a little science may at last be introduced into the most intriguing chapter of vital chemistry. It were time that some emphasis were laid upon the need of our exercising more imagination in dealing with its problems. As the Duchess said to Alice, "Everything's got a moral, if only you can find it."

Combustion Studies

Her further remark, "Oh, 'tis love, 'tis love, that makes the world go round," was wonderfully verified in a quarter scarcely to be expected, in the comprehensive Bakerian Lecture given, in May, by Professor Bone, to the Royal Society. Discussing the supposed preferential combustion of hydrogen in hydrocarbons, Professor Bone gave a series of demonstrations in which mixtures of hydrocarbons, CH₄, C₂H₆, C₂H₂, with an equal molecular proportion of hydrogen, were exploded with only sufficient oxygen to burn the hydrogen. No hydrogen was burnt: only the hydrocarbon is attacked and, in the first instance, hydroxylated. A kinetic behaviour is ruled out by such results. We are back in the ball room, where attractive looks prevail: the oxygen dancers won't pair with any young combustible spark they may meet but calmly relegate the poor water-born youth to wallflower positions, dancing only with hydrocarbon partners as long as these are to be had. Is it perhaps because the hydrocarbon savours of spirit? What too of chain reactions and thermo-dynamic argument?

At very high pressures the results are seemingly otherwise; if not contrariwise. Carbonic oxide exploded with air gives rise to a high proportion of nitric oxide. Professor Bone suggests that, the burning carbonic oxide, in some way, casts the glad eye upon the nitrogen molecules and makes them specially anxious to join the dance. We incline to favour crowd tactics, as the explanation. Not only are Professor Bone's combustion inquiries remarkable, he has also advanced far in his studies of the nature of coal; in this field, he still has a very long, if not endless, furrow to hoe; having devoted assistants, he will not be lonely. Strange to say coal is seemingly a reconstructed synthetic organic complex of no great complexity—so it is easily hydrogenated.

Professor Finch's electro-chemical studies of combustion open up an unexplored field; they are the first attempt to deal with the subject rationally, in a comprehensive manner. Should the South Kensington example tell and exact work in this field become the rule, we shall know something someday of the process of gaseous oxidation: the mystery of carbonic oxide will be solved.

Finally, an event of real importance to be chronicled is the issue, by the Managers of the Royal Institution, of the first two (of seven) volumes of the reproduction of Faraday's notebooks, which they have munificently undertaken. Our thanks

are specially due to the secretary, Mr. Martin, for the self-sacrificing devotion he has displayed in securing an accurate rendering of the notes and of Faraday's marginal sketches. Never before have students had such opportunity of studying the mind of an experimental philosopher.

Did space permit, much might be said of the progress made in the study of plant colouring matters, of the sterols, of fatty materials, of enzymes and other organic oddments. Here and there, chemists are doing very wonderful work: we may close the year with hope, if not with glory.

The Ceramic Society

Papers Presented during the Year

THE three sections of the Ceramic Society have continued to provide valuable papers dealing with topics of interest to members and others connected with the various ceramic industries. In reviewing briefly the Society's activities during the year, the sections may be considered conveniently in turn, although some papers have bearings on the work of more than one section. The Pottery Section held its usual monthly meetings at the Society's headquarters at Stoke-on-Trent, whilst the other two sections arranged two joint meetings, each lasting several days, one in May at Folkestone, the other at London in September.

Among the contributions at the Stoke meetings were the following: Bernard Moore, in a paper on "Placing Materials for Bone China," strongly recommended for the purpose a mixture of calcined bone ash (75 per cent.) and calcined alumina (25 per cent.). This should be of special importance to English china manufacturers. A. J. Bradley and A. L. Roussin gave an account of "An X-ray Study of Porcelains and their Relation to Mullite." L. A. Mitchell described a method for "Continuous Filtering and Drying of Pottery Slip."

Refractory Materials Section

For the Refractory Materials Section, in two papers by Dr. J. H. Chesters and Dr. W. Weyl much light is thrown on the behaviour of dead-burned magnesite during the "souring" process, which should enable manufacturers of magnesite bricks to avoid excessive losses. W. J. Rees described investigations during twelve years concerning the durability of blast furnace linings, and offered suggestions to blast furnace managers, based on results obtained, which have apparently proved valuable. A. T. Green presented an important contribution entitled "Observations on the Behaviour of Refractory Materials in Continuous Vertical Retorts," which has a bearing on refractories used in other industries, as well as gasworks. Professor J. W. Cobb reported on "The Behaviour of Refractory Materials under Torsion, at Different Temperatures." This constitutes a study of refractories from a new angle. R. J. Sarjant aroused great interest by his paper on heat resisting steels, the use of which has increased largely, especially since the maximum temperature to which some of these steels can be exposed safely has been substantially raised. This was made possible by the results of continued research.

Building Materials

For the Building Material Section, C. H. J. V. Phillips discussed "Research, and Some Modern Tendencies in the Structural Clayware Industries." A. Zaiman and B. H. Wilsdon severally made "Contributions to the Discussion of the Standard Specifications for Clay Building Materials," the former dealing with "Specifications for Clay Building Materials in Relation to Manufacturing Technique," and the latter with "Statistical Control and Specification of Quality." John Procter described a new system of stiff-plastic brickmaking, and W. Emery presented an "Attempted Heat Balance on a Manchester Kiln." Other contributors to this section included I. Lubbock ("Oil Fuel in the Brick Industry"), L. J. Sykes ("The Design of Forming or Extruding Dies for Clayworking"), W. Barnes and A. H. Wade ("Excavators for the Clayworker"), and J. F. Kayser ("Heat-Resisting Metals and their Use in the Ceramic Industry").

Chemical Engineering Progress During the Year

By A. J. V. UNDERWOOD, D.Sc., M.I.Chem.E.

IN any review of the year 1932, even one dealing with chemical engineering, some reference cannot altogether be avoided to that King Charles's Head, the economic crisis. The allusion is justified even in the relation between the state of health of the sufferer and the frequency of manifestation of the bogy. References to the crisis now appear *ad nauseam* on all occasions, relevant or irrelevant, and it is rapidly becoming—if it has not already become—an explanation or excuse for anything and everything. There is, however, a connection between chemical engineering progress and the economic situation much closer and more fundamental than that between the proverbial elephant and the Irish question.

Progress in chemical engineering, like that in any other branch of engineering, depends ultimately on experiment and the experience derived from it. Practically every new plant that is built is to some extent an experiment. Some new feature is incorporated, some modification is made as a result of previous experience, or some increase in size is attempted beyond that already achieved. Every such experiment, when tried out in practice, yields a useful result, sometimes trifling, sometimes important. Even a negative result or a failure yields useful knowledge, though it may not be so widely published and advertised as a success.

Opportunities Afforded by the Depression

Economic depression and the urgent necessity for reducing costs frequently leads to progress as a result of intensive searching for even the smallest improvements which, though individually unimpressive, may in the total represent a substantial gain. The difficult period of inflation in Germany was thus responsible for considerable progress in reducing costs of production at a time when other countries had hardly appreciated the importance of the so-called trifles. At a time when a factory is working below capacity, opportunities are present for experiment and investigation of large-scale plant operation, which could not possibly be carried out during a period of normal production on account of the danger of interference with the output. To what extent such opportunities are being generally utilised instead of adopting the facile policy of waiting till better times return it is impossible to tell. In times of economic depression the far-seeing manufacturer buys such plant as he will require in the future, knowing that when prices of metals are in the depths and there is cut-throat competition to obtain his orders he can secure his plant at prices which will appear ludicrous when normal conditions return. Moreover, he will be ready to take advantage of any improvement in trade while his competitor, who has been following the policy of so-called "sound caution and economy," will then start to buy his plant at higher prices and to wait for delivery of it.

In a year such as 1932 a list of new works constructed or old works substantially extended cannot be very imposing when all countries are suffering from the same troubles. The only country in which construction of chemical plants on any substantial scale is taking place is Soviet Russia, where many factories have been built or are being built under the Five Year Plan. The main activity seems to have been directed towards the construction of such plants as have a bearing on agriculture, for example, plants for sulphuric acid, super-phosphate, synthetic ammonia, nitric acid, cyanamide and potash. Considerable developments are also reported in connection with by-product coking plants and electro-chemical industries to be based on the large Dnieprostroi power plant. American design and construction have predominated in these plants, largely due, no doubt, to the employment of American advisers and operating staff. British plant manufacturers do not appear to have secured anything like a due share.

Some New Works

An installation of some magnitude completed this year is the new coke oven plant of the Gas Light and Coke Oven Co. at Beckton. This plant, which was formally opened by the Prince of Wales in May, is the only one of its kind operated by a town's gasworks in this country. A new installation of

coke ovens at the Normanby Park Works, Lincs., of John Lysaght, Ltd., attracted some attention as being the first plant in Great Britain fired by blast furnace gas. An announcement was made by Stewarts and Lloyds, Ltd., of their intention to build a large steel plant for the production of basic Bessemer steel from the iron ore deposits at Corby, Northants. The cost is estimated at over three million pounds and a plant for tube manufacture is also to be erected on the same site.

The possibility of home-produced petrol by the hydrogenation of coal still continues to be a subject of discussion. The successful establishment of large-scale plants in the United States for hydrogenating petroleum oils has resulted in considerable advances in technique, but the application of the process to coal does not yet appear to rest on a self-supporting economic basis and would necessitate some form of Government assistance. A promising development in regard to home-produced fuel is the use of compressed gas as a fuel for motor vehicles. The production of light-weight cylinders of nickel-chromium-molybdenum steel, carrying gas compressed to 3,000 lb. per sq. in. has enabled the dead load to be reduced considerably. Experiments at Birmingham show that gas at 4d. per therm is equivalent to petrol at 6d. to 7d. per gal. Other advantages are also claimed such as less need for de-carbonisation and the absence of oil dilution.

The use of nickel-chromium alloy steels continues to develop as experience in their methods of fabrication and applications increases and as their limitations as well as advantages become more clearly recognised. The addition to a nickel-chromium steel of selenium to the extent of 0.25 per cent. is stated to give an alloy which can be drilled, threaded or otherwise machined with ordinary shop tools, while at the same time increasing the corrosion resistance to many substances, such as acetic acid and aluminium sulphate.

Plant Fabrication

An interesting example of plant fabrication was the production by Thos. Firth and John Brown, Ltd., of a reaction chamber for a cracking unit in Trinidad which is claimed to be the world's largest hollow forging. The forging operation appears to have been extremely accurate, the finished bore being machined to $71\frac{1}{4}$ in. diameter from a forging which measured $69\frac{1}{2}$ in. internal diameter. The finished reaction chamber had an overall length of 48 ft. and a weight of approximately 66 tons.

The use of nickel appears likely to extend as a result of the introduction to this country of nickel-clad steel plate, a sheet of pure nickel being bonded by welding to a steel plate. The material is available in five standard thicknesses of nickel varying from 10 to 20 per cent. of the total thickness and it renders possible the construction of large pieces of plant such as pressure vessels, evaporators or tank cars with a reliable lining of pure nickel. The construction in pure nickel of an ebullition chamber, 23 ft. long and weighing 4 $\frac{1}{2}$ tons, for the concentration of caustic soda liquor has also been reported.

Certain elements which, not many years ago, were of little more than scientific interest appear to be assuming commercial importance. By the addition of 2 to 3 per cent. of beryllium to copper or bronzes, alloys can be obtained with greatly increased strength and ductility and with a hardness sufficient to permit of them being used as spring metal. A copper alloy with 6 to 7 per cent. of beryllium has a Brinell hardness of 750 corresponding to that of a very hard steel. Lithium also appears to be a promising alloying element, particularly for light aluminium alloys, giving increased strength, hardness and improved working properties.

The possibility of harmful results from the use of aluminium vessels in the cooking of foods or food products was investigated by Dr. J. H. Burn, director of the Pharmacological Laboratories of the Pharmaceutical Society of Great Britain, his report being published by the British Non-Ferrous Metals Association. It was concluded that the use of aluminium vessels does not involve any danger to health and that aluminium salts produce no harmful effects unless directly introduced by injection into the body in large amounts. This

conclusion should remove the uncertainty which has sometimes hindered the use of aluminium in the food industries.

An interesting material of construction is one produced by the impregnation of wood with tin, lead or other low-melting metals. This "metallised" wood is easily worked and is very suitable for certain types of bearings as the wood absorbs a certain amount of oil and so aids lubrication. The rapid transfer of heat from the bearing surface by the metal is a further advantage. Carbon also appears to be developing as a constructional material on account of its high resistance to sulphuric acid, hydrofluoric acid and phosphoric acid. It has been used for some time in Cottrell precipitators in sulphuric and phosphoric acid plants, and carbon blocks have also been used for lining digesters for the cooking of pulp in paper making, both in acid and alkaline processes. More recent developments are the production of impervious carbon pipe, which can be used under appreciable pressures, and the use of carbon impellers for pumps carrying corrosive liquids.

A Notable Development

Materials which appear likely to find use as protective coatings against corrosion are chlorinated rubber products and the synthetic drying oil, known as S.D.O., brought out by the Du Pont Co. The chlorinated rubber compounds have a good resistance to acids, alkalies and aqueous salt solutions. The brittleness of the film can be reduced by the use of plasticisers such as diethyl phthalate and tricresyl phosphate. S.D.O. is made by the polymerisation of divinylacetylene and its hardening is due to further polymerisation rather than to the absorption of oxygen from the air. It is applied diluted with a suitable solvent and dries rapidly, giving a film which is much more impervious to water than a linseed oil film and which is unaffected by organic solvents and by most acids and alkalies with the exception of strong oxidising agents.

The changed fiscal policy of Great Britain and the abandonment of the gold standard has assisted British plant manufacturers to secure a larger share of the home market and the export market, though the steady decline in international trade is likely to prevent export business from assuming important proportions until world economic and political conditions become more stable. As a result of the changed conditions, for instance, the manufacture of glass-lined steel vessels and chemical stoneware has developed increasingly in this country. An investigation is being made by the Association of British Chemical Manufacturers in conjunction with the British Chemical Plant Manufacturers' Association into the alleged difficulties of obtaining satisfactory British lead-lined plant and chemical stoneware by collecting data from users of such plant. A similar inquiry is being made to ascertain the reasons for the considerable decline in export and increase in import of British-made filter presses.

Heat Transmission

In the field of heat transmission, increasing use is being made of diphenyl, diphenyloxide or a eutectic mixture of the two where accurate temperature control at high temperatures is desired. For small stills it is being employed in conjunction with electric heating. An interesting application is to a cylindrical reaction chamber where heat is evolved at one end and must be removed, while heat has to be applied at the other end. The use of a jacket partly filled with high-boiling fluid renders it possible to transfer heat from one end to the other and to maintain the temperature within close limits. A new dryer for crystalline solids is the Jenkins vertical centrifugal dryer, which consists of a cylindrical shell containing a central rotating shaft carrying a number of metal dishes. The shell carries a corresponding number of metal cones so that when the material to be dried is fed on to the topmost dish it is flung off by centrifugal force against the cone, from which it falls by gravity to the next cone and so on. By this means the material is brought into intimate contact with the ascending stream of hot air and the vertical construction necessitates less floor space than would be required for a horizontal rotary dryer.

An interesting example of the utilisation of low-grade heat is the manufacture of salt as a by-product in a petroleum refinery in Oklahoma. Natural brine is used as cooling water in the refinery condensers and the heat thus obtained is used to evaporate the brine. The manufacture of potash salts, common salt and bromine from the Dead Sea is also increas-

ing. The brine used in the process is now drawn from a depth of 175 ft. in the sea at the content of salts is highest at this point. For this purpose a pipe line, 2,500 ft. long and 30 in. dia. was laid on the bottom of the Dead Sea.

The adoption in many countries of legislation for the compulsory use of alcohol in motor fuel to aid agricultural producers has stimulated the production of absolute alcohol and the development of processes for the dehydration of alcohol. A number of plants have been erected to work the Haig process, in which alcohol vapour is dehydrated by contact, in a distilling column, with an alcoholic solution of an alkaline acetate. The aqueous salt solution drawn off at the bottom of the column is evaporated and the salt is used again. One large-scale test at Dessau showed a steam consumption of only 64 kgs. of steam per hectolitre of 99.8 per cent. alcohol, when starting with liquid 94 per cent. alcohol. Another method which has received some attention is that of Fritzweiler and Dietrich, which is an azeotropic method using trichlorethylene as the entraining agent.

Separating and Mixing Machines

A new continuous centrifugal machine for the separation of crystalline materials from liquid with a final washing is the Sharples Super-Xtractor. It consists of two conical bowls rotating at different speeds, the inner one carrying a series of small scrapers or ploughs which propel the solid matter upwards through the outer bowl. After the liquid has been removed, washing takes place and the solids are discharged continuously in the dry state. A machine for separating suspensions with a high solid concentration is the N.S. centrifugal sludge separator, which permits of the extracted solids being discharged while operating at full speed. The bowl is of a special construction, consisting of two telescopic sliding parts, and it is opened by the hydrostatic pressure generated by centrifugal force acting on water admitted to the machine for this purpose. The construction is such that this water does not mix with the liquid which is being centrifuged in the machine.

A new mixing machine of simple construction, suitable for the mixing of dry powders, is the Dri-Mix machine. It consists of a mixing chamber made up of three pyramidal sections, the material falling from one section into the next one as the chamber is rotated. The British Rema centrifugal mixer and emulsifier is a new machine for mixing and emulsifying solids and liquids continuously or in batch operation.

As the use of indicating and recording instruments and automatic control increases, new types of instruments are being developed. The use of the photo-electric cell as a relay has permitted of machines being constructed for automatic sorting or counting, the colour-sensitivity of the cell being a valuable property in this connection. It has also been used on conveyor weighing machines to eliminate mechanical connection between the weighing and integrating mechanisms. A continuous gas indicator with high sensitivity and automatic operation is the Fagelston indicator.

Bulk Transport of Chemicals

The necessity for reducing costs of distribution as well as costs of production is leading to developments in the bulk transport of chemicals. Aluminium alloys are finding increasing application in the manufacture of tank cars, the reduced weight and increased carrying capacity compensating for the higher first cost. The improvements in welding technique permit of the use of nickel-chromium steel for the bulk transport of nitric acid and foodstuffs such as milk. For transporting iron-free and copper-free caustic soda for artificial silk works, tank cars of nickel-clad steel have been successfully used. Tank cars are also being used for handling dry materials in bulk, as in the Dry-Flo tank car, which is equipped with drag chain conveyors for conveying the material to a central hopper at the bottom of the car, thus ensuring rapid and complete discharge.

A gratifying feature of the year is the continued increase in appreciation of the value of chemical engineering training. Larger numbers of students are taking advantage of the facilities provided at the various educational centres and employers are increasingly appreciating the value of such a training for their staff. As this development progresses, this country should soon possess some valuable centres of chemical engineering research.

Conditions in the Heavy Chemical Industry

By P. PARRISH, F.I.C., M.I.Chem.E.

TRADE depression and unemployment still continue, despite the fact that the National Government has been hard at work for more than twelve months. The two essential problems, (a) war debts and reparations, and (b) unemployment, have not yet been solved. These are not national, but rather international, questions, and demand international consideration and solution. The departure from the gold standard, the Import Duties Act and the Ottawa agreements will undoubtedly stimulate trade. Indeed, a sensible fillip has already been given to the heavy chemical industry.

Synthetic Ammonia

A perusal of the literature published during the past year leads one to the conclusion that technical progress in this industry has momentarily languished. For an industry so young, the patents list has nothing of a revolutionary character. This is not surprising. The histories of other industries have shown similar tendencies. The development period is characterised by great technical activity. This is invariably followed by a period of consolidation, during which the industry becomes established, and processes become standardised. A few modifications have been proposed, chiefly relating to the movement of the gases within the reaction chamber. None of these, however, is of great moment. No new catalyst has been proposed, although slight modifications, especially relating to activators, have been patented. As an example, Brit. Pat. 359,378 proposes the addition of small quantities of arsenic, boron or phosphorus, or other compounds, to the usual activators, added to an iron catalyst.

A process for the production of ammonia is proposed by F. Lawaczeck (1). Hydrogen under high pressure, produced by electrolysis of water in a closed vessel, is passed to a collecting vessel through a heated pipe, where traces of oxygen are converted into water vapour, and thence to a nozzle, where it is mixed with nitrogen, admitted as a liquid, but gasified by the hydrogen. The synthetic apparatus comprises a series of concentric cylinders, having the catalyst material in the upper portions of the intermediate annular spaces, and a series of vertical tubes. The gas mixture, under high pressure, is introduced at the base, becomes cooled by the nitrogen, and is then conducted to the catalyst in the central cylinder, whence the gases containing ammonia pass down the tubes to the base, in which ammonia is condensed. The downward-flowing gases serve, in their passage, to heat the reacting gases which ascend.

Direct Synthesis

A process for the production of nitric acid by direct synthesis has been devised by G. Fauser (2). The gases from the convertor are cooled to remove the greater part of the water as dilute nitric acid. The remaining gas is compressed to 8-10 atmospheres, passed through an oxidation tower, then cooled to -10° C. and mixed with dilute nitric acid. Treatment with oxygen at 70° C. and a pressure of 50 atmospheres yields 98 per cent. nitric acid. Absorption is thus avoided. Du Pont de Nemours and Co. (3) have a similar patent, which involves the successive oxidation and absorption of the nitrogen oxides. According to Lonza, Elektrizitätswerke and Chem. Fabr. A.-G., the reactions are accelerated by finely dividing the stream of oxygen. With a mixture of 50 per cent. HNO_3 and N_2O_4 at 80° C., 95 per cent. nitric acid is obtained after passing oxygen at 15 atmospheres for three minutes.

A new catalyst for the oxidation process, proposed by L. J. A. Marmier (4), is prepared by saturating a porous refractory material with metallic salts, then drying and igniting to liberate the metals or their oxides, preferably in greater concentration towards the outer surfaces of the material.

Low and high temperature carbonising processes have their specific rôles. Despite the chequered career of many low temperature carbonising processes, it would appear that the one developed at Barnsley and Askern bids fair to become an

economic success. The form and metal of construction of the retort must be such as admit of equable heating, with a minimum of calorific expenditure. It should be such that suitably blended coals can be charged without difficulty, the intumescence during carbonisation must spend itself in compressing the charge undergoing treatment without binding in the retort, and it should be such that complete discharge can be effected in a minimum of time. It is certain that these desiderata can now be secured, and a robust fuel, of ready ignitability and of a high degree of combustibility, with low ash and moisture contents, can be obtained. The treatment of the resulting coal oil by (a) distillation or (b) hydrogenation is undoubtedly a profitable concomitant operation.

Low Temperature Tars

The Department of Scientific and Industrial Research published a technical paper (No. 32) during the year, on low temperature tars and spirits (5). The largest conversion of spirit has been obtained by using activated charcoal or silica gel, impregnated with ammonium para-molybdate, with sulphur added separately. Sodium and chlorine, in very small amount, rapidly destroy the efficiency of a molybdenum catalyst. Water and ammonia, in some cases, exert a profound influence on the course of the reactions when using such a catalyst, but the mechanism of their actions has not yet been elucidated. Experiments conducted on coal oil suggest that by the use of ammonium molybdate-charcoal-sulphur catalyst, the volume of oil obtained is the same as that of the original tar. The volume of hydrogenation for the conversion of 20 gal. of coal oil to oil is 1,250 cu. ft.

Kenneth Gordon (6) has declared that low temperature tar is an admirable raw material for hydrogenation, and an 80 per cent. yield of petrol is obtainable by this method. Mr. Tizard's letter, published in "The Times," December 10, 1932, deals with the hydrogenation process, by which petrol is obtained from British coals. He makes clear that any delay in proceeding in this matter is not due to technical imperfections, or to any tenderness towards companies which produce or distribute imported oil, but rather to the fact that the process is demonstrably uneconomic.

Sulphuric Acid

The extent of the production of sulphuric acid in this country has remained much the same as last year. With the introduction of automatic processes for the inexpensive production of concentrated gas liquor, it was felt that the tendency to destroy gas liquor would be arrested, and that sulphuric acid manufacturers would derive a distinct advantage. To what extent such advantage has accrued it is difficult at the moment to say, but sooner or later the influence of automatic gas liquor concentration processes must be felt.

The Petersen tower system, a large installation of which was erected at Kalundborg two years ago, has been criticised by F. Schuck (7), on the ground that it incurs excessive pumping costs and losses of nitrogen, according to the concentration of the nitrous vitriol used. A further aspect of criticism is excessive corrosion of the lead of the production towers. The Rochamel-Bodamer tower system, in which gases rich in nitric oxide are recirculated by a fan, is said to be free from these difficulties. Petersen's reply (8) questions the importance of gaseous nitric oxide as contrasted with liquid phase working, and refutes the suggestion that the use of concentrated nitrous vitriol leads to nitrogen losses. As regards corrosion, dry nitrogen peroxide is said to be more injurious than nitrous vitriol.

The Gaillard-Parrish system of liquid phase sulphuric acid manufacture continues to gain favour, because it can be worked at 2 to 3 cu. ft. of chamber space with unerring regularity, and with comparatively low surface lead temperatures. The horse-power absorbed in the dispersion of acid in connection with a 15,000-ton per year plant is only 3 h.p. per hour. The turbo dispersers operate in an efficient way, with

(1) U.S. Pat. 1,815,410.

(2) "Chem. and Met. Eng." 1932, 39, 430.

(3) U.S. Pat. 1,840,063.

(4) Brit. Pat. 369,153.

(5) CHEMICAL AGE, 1932, 26, 23.

(6) "Financial Times," Fuel Supplement, December 5, 1932.

(7) "Chem. Zeit." 1932, 56, 664.

(8) *Ibid.*, 664.

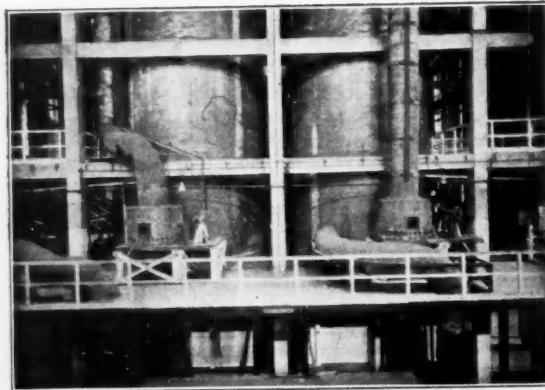


Fig. 1.—Gaillard-Parrish Liquid Phase Sulphuric Acid Plant, erected on the Continent in 1931-1932.

comparatively little attention. Part of two large units of Gaillard-Parrish plant, recently erected on the Continent, is shown in Fig. 1, where the ferro-concrete structure used as a skeleton can be clearly seen.

In conjunction with the same plant, efficient electrostatic dust chambers (Fig. 2) have been erected as part of the pyrites combustion equipment. The necessity for the removal of iron oxide dust from burner gases on their way to the Glover tower is generally recognised. The quantity of dust recovered is usually of the order of 1 per cent. of the weight of the pyrites burned. Dust which contains less than 20 per cent. of lead is difficult to dispose of; indeed, the saleability of the recovered dust appears to be a function of the lead and arsenic contents.

Analysis of the Dust

An analysis of a typical dust arising from the combustion of Rio Tinto washed pyrites fines is as follows: Lead, 12.17 per cent.; arsenic 1.70 per cent.; sulphur, 7.65 per cent. No market could be found for this dust. An analysis of another dust, which found a ready sale, was as follows: Lead, 17.50 per cent.; arsenic, 1.50 per cent.; sulphur, 5.50 per cent. The recovery of dust of ready saleability constitutes an interesting problem. It has relation to the chemical and physical characteristics of pyrites, the conditions of their combustion and the temperature at which the gases are treated in the electrostatic precipitator. Usually, about 40 per cent. of the lead in pyrites is recovered from the dust precipitated in the treater.

The fuel-less concentrator to which reference was made last year is fulfilling all the anticipations held out. Now that C.O.V. can be manufactured by the chamber process at a cheaper price than by the contact *etc.*, it cannot be doubted that renewed vigour has been given to the chamber process. Automatic control of sulphuric acid plants of the liquid phase type is possible, and this is a development which the future will undoubtedly witness.

During the year rotary mechanical sulphur burners (Thorncliffe type) have been put on the market for dealing with low-grade brimstone, and with brimstone which contains oil or asphaltic matter. With the latter quality, combustion is sluggish, or is definitely arrested after a time. By the improved burner such brimstone can be burned at a greatly accelerated rate, and continuously. Brimstone containing up to 7 or 8 per cent. of ash can now be dealt with in the improved type of rotary mechanical sulphur burner. The ash is discharged partly at the burner-head and partly on the floor of the secondary combustion chamber. That such continuous combustion, without the necessity for any stoppage, constitutes an attractive feature cannot be doubted.

By-Product Ammonia

With a view to reducing the production of ammonium sulphate, certain Continental synthetic ammonia works, namely, Sluiskil and Poland, are being put out of commission, and a yearly grant is being made to the companies concerned. Despite these steps, and the adoption of quotas, the produc-

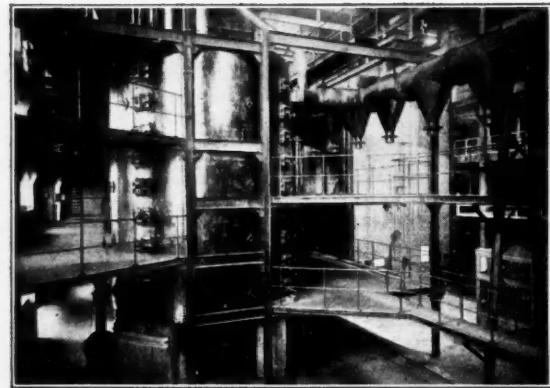


Fig. 2.—Pyrites Combustion Plant with Electrostatic Dust Chambers at Gaillard-Parrish Liquid Phase Sulphuric Acid Plant.

tion of ammonium sulphate is in excess of demand, and inordinately low prices still prevail. The need for centrally-situated chemical works to deal with by-product ammonia, which the writer has consistently urged for several years, becomes more pressing than ever.

The Liquor Effluents and Ammonia Sub-Committee of the Institution of Gas Engineers still continues its labours, but a practical solution of the problem will alone come from determined action on a large scale. The method of disposal of spent liquor arising from gas liquor distillation plants has been simplified. It is now agreed, after much inquiry and investigation, that the best and least expensive method of disposal is to send the liquor to the sewers. Sewage works can invariably treat such effluent liquor at a small or almost negligible cost. This method is to be preferred to the adoption of purification plant for the treatment of such effluent liquors at gas or chemical works.

Ammonium Bicarbonate

Processes for the production of ammonium bicarbonate have been patented during the year, but the extent of their adoption depends on the result of trials which are now in hand, directed to determining the relative merits and suitability of ammonium bicarbonate as a fertiliser in contrast with ammonium sulphate. If a demand for ammonium bicarbonate is to be created, it will be necessary to manufacture this product at a price comparable with that of sulphate of ammonia. In other words, the average gross price, on the basis of the current year's schedules would be approximately 5s. per unit of ammonia \times 21.5 units = £5 7s. 6d. per ton, farmer's station.

Gas liquor can now be converted to concentrated ammonia liquor by an improved form of automatic plant, and such product is peculiarly suitable for conversion to nitric acid in an ammonia oxidation plant, for use in connection with sulphuric acid units. There is no need for liquor ammonia containing 25 per cent. NH_3 , which is relatively pure in other respects. A concentrated ammonia liquor containing, say, 20 to 22 per cent. of ammonia, with approximately 0.4 per cent. H_2S , 2 per cent. of CO_2 , and 2.5 to 3 per cent. pyridene, is satisfactory for the purpose in question, and is obviously a cheaper raw material than liquor ammonia containing 25 per cent. NH_3 .

Alkali Manufacture

What was said last year still holds true—if salt were more readily available, it is certain that the by-product ammonia industry would not hesitate to embark on the production of soda ash and caustic soda by the ammonia-soda process.

The need for an alkali industry in Australia is gradually being realised. No less an authority than the Port of Adelaide has expressed this view. Imports of alkali amount to some £300,000 per annum, and it is urged that the production of this alkali within the Commonwealth would lead to a substantial increase of employment. The Minister in charge of development has the matter under consideration.

Considerable attention has been given to the subject of separation of sodium and potassium salts from natural or by-product liquors, containing complex mixtures of salts. Searle's Lake brine is an example of one of the more impor-

tant natural liquors from which sodium carbonates, sulphates and borates, as well as potassium salts, can be recovered by suitable treatment (9). Methods for the manufacture of caustic soda from sodium chloride, involving the intermediate formation of sodium silico-fluoride, have been proposed by Kessler and others. The "Kiflu" process, which is a modification of these earlier proposals, is a thoroughly practical one, and has certain advantages (namely, in the purity of the product, and the reduction in evaporation of water), over the Solvay process.

Phosphoric Acid

The significant improvements mentioned last year in the manufacture of phosphoric acid still merit attention. They represent a marked advance on former technique. Mono-ammonium and di-ammonium phosphates have not met with the favour that was anticipated. Whether this is due to prejudice, or some inherent disability, remains to be seen. The results of experiments which were conducted on an approved method in 1930 on potatoes, sugar beet and oats, over Great Britain, with new concentrated fertilisers, based on ammonium phosphate, have shown that in these trials there is no significant difference in the yield between the new compound and mixed fertilisers. It is too early yet to say whether calcium sulphate, which is contained in the calcium superphosphate of a mixed fertiliser, and is absent from the new compound, exerts any influence.

Calcium Superphosphate

What was said last year about collaboration between the gas and coking industries and the superphosphate industry can be repeated. There is opportunity for mutually satisfactory arrangements being reached. The ammoniation of calcium superphosphate still continues in America on a large scale, and several works in France have adopted this process. New processes for the manufacture of calcium superphosphate have been introduced to this country, and indeed have been adopted by leading fertiliser manufacturers. The Broadfield process has been installed in London, and the Overphos process is being erected at a new works in East Anglia.

The Broadfield process aims at producing a drier calcium superphosphate than has hitherto been marketed, in a continuous manner. The importance of greater time contact between the phosphate rock and acid undergoing reaction in the mixing process has been appreciated. Powerful fans are used for rapidly withdrawing the steam and products of acidulation. This process was first operated at Valdosta, Georgia, about four years ago.

The Overphos process is essentially one of an autoclave kind. A charge of 6 tons of acid and phosphate rock is treated in about $1\frac{1}{2}$ hours. This includes charging time, reaction period and discharging time. The pressure at which the autoclave is worked is about 60 lb. per sq. in. After completion of the digestion, a vacuum pump is started, and a powerful suction is exerted on the autoclave. The object is to remove rapidly the products of decomposition, and to aid the formation of as dry a product as possible. The material leaves the autoclave as a sinter, or clinker, is discharged to a belt conveyor, and passes to a disintegrator, where it is cracked, or crushed, and subsequently differentially screened.

Modifications in Processes

The advent of these processes to this country has led English plant manufacturers to introduce modifications to their processes, which must inevitably lead to the production of a vastly improved calcium superphosphate. The aim of the superphosphate manufacturer is to produce a material in which the content of water-soluble phosphoric acid is retained at a high value. This property is largely determined by the proportions of ferric oxide and alumina in the raw phosphate. Mono ammonium phosphate, when brought into contact with combinations of these oxides, undergoes a process of reversion, by which phosphates insoluble in water are formed. This undesirable process can be avoided if the finished product contains sufficient phosphoric acid, in excess of that accounted for by the mono-phosphate, to form phosphates with the ferric oxide and alumina.

In practice, about one-fifth of the phosphoric acid exists in the "free" form. Unfortunately, however, the expression "free acid" is often taken to mean free sulphuric acid—a

definitely harmful conception, which attributes undesirable properties to the product. Actually, of course, free sulphuric acid cannot exist in the presence of mono calcium phosphate, as these compounds would react to form calcium sulphate and free phosphoric acid. A number of analyses of superphosphate of German, French and Danish origin show free sulphuric acid contents of from 0.01 to 0.03 per cent. SO_3 .

There is a growing belief that legislation directed to assist agriculture in a practical way is long overdue. If we are to mitigate the effects of unemployment, or if we are to solve even partially the unemployment problem, an effort must be made to get a large proportion of our younger men back to the land. An assisted agricultural industry, for a pre-determined period, during which endeavours are concentrated on developing on economic lines certain specialised activities, necessitating the employment of a large proportion of our unemployed men, will prove a better proposition from the country's viewpoint than a well-nigh moribund industry with youths on the dole. Whatever support is given to the agricultural industry, it is certain that calcium superphosphate manufacturers will benefit.

The Institute of Chemistry

Principal Events in 1932

AN important feature of the proceedings of the Institute of Chemistry during 1932 was the inauguration of a scheme under which lectures are given on the trend of modern developments in the main branches of chemistry, the object being to afford information to chemists who, having left college for some years and having been engaged in industry and other practice, find difficulty in keeping touch with the progress of modern thought. Two lectures were given, in April, by Professor Robert Robinson on "The Development of Conceptions based on the Electronic Theory of Valency in Organic Chemistry," and two lectures, in October, by Professor A. J. Allmand on "The Nature of Simple Molecules and of Elementary Processes." Professor Robinson's lectures were published in November, and Professor Allmand's lectures will be issued shortly. The next two lectures of the series will be given by Professor G. T. Morgan, on inorganic chemistry, in April, 1933.

The Streatfield lecturer was Mr. W. A. Williams, who dealt with the subject of "Rubber"; and the Gluckstein lecturer, Sir Frederick Gowland Hopkins, who subject was "Chemistry and Life." These lectures will also be published. The local sections also have received some notable lectures on professional and technical subjects, and their meetings have been well attended.

The Patents and Designs Bill

Among the matters in which the Council of the Institute has been concerned during the past year may be mentioned the Patents and Designs Bill, in which the president, Dr. Clayton, took a leading part in watching the measure through the House of Commons. The subject of the employment of alien chemists has also been under consideration. Dr. Clayton has asked questions in the House of Commons with regard to the employment of such aliens in the beet sugar industry, and the Institute has been in close touch with the Ministry of Labour on matters arising out of requests from firms to be allowed to import alien chemists for work in connection with other industries. In addition, the Council has dealt with such questions as industrial administration, testing work for the building industry and other matters affecting the professional interests of chemists. The records of the appointments register still show about 3 per cent. of the members to be unemployed, the number varying from 189 to 204 during the last six months of the year.

Examinations for the Associateship and Fellowship have been held as usual in London and other centres. From time to time, applications are received from colleges for recognition as institutions approved for training candidates for the Associateship of the Institute, and the Council is thus afforded opportunities of making suggestions for the improvement of the standard of training available and the equipment in such institutions, several of which have been added to the approved list during the year.

Recent Progress in Fine Chemicals

By FRANCIS H. CARR, D.Sc., F.I.C.

IN view of the present conditions of stringency, it is perhaps somewhat remarkable that although most firms concerned in fine chemical manufacture have been compelled to curtail their research and development programmes, there is ample evidence of continued expansion. In general, there has been a tendency on the part of most manufacturers to maintain their staffs with only the smallest depletions, but nevertheless to concentrate attention upon perfecting existing manufactures, thus avoiding new capital outlay. With few exceptions prices have continued at the low figures to which they have fallen in recent years, with the result that profits are small, taxes high and dividends few, thus leaving small margins for capital expansion. In spite of this, several fine chemical manufacturers have extended their plants and undertaken new manufactures, and in many directions there is unmistakable evidence that the energetic development of the fine chemical industry which has characterised the period since the introduction of the Safeguarding of Industries Act in 1921 has only been partially checked by the general trade depression. It is reported, for example, that new plant has been erected for producing hexamethylene tetramine, hydroquinone, resorcinol, rhodinol, phenacetin and phenolphthalein, all well-known synthetic chemicals which until comparatively recently were entirely imported. No doubt the departure from the gold standard and the imposition of import duties have provided in Great Britain a stimulus which has in part offset the effects of the general depression.

Openings for the British Manufacturer

We are still only at the beginning of an age in which fine chemicals will be put to greatly extended uses. In the working out of these new uses for chemical products our American cousins and our German friends are setting a magnificent example to British manufacturers. Almost every advance in new plastic materials, resins, solvents, paints, dyes, cosmetics, flavouring agents and drugs means new opportunities for the fine chemical manufacturer; continued development is therefore a fundamental part of the healthy life of the fine chemical industry, and one cannot contemplate with equanimity a long continuance of the present trade depression without misgivings as to its final effect on general progress. The announcement that the manufacture of phenacetin has recently been recommended in Great Britain is particularly satisfactory. During the war period, large quantities of phenacetin were manufactured at high cost, but this manufacture was abandoned mainly as a consequence of the fierce competition resulting from the low prices which obtained in 1919-20. Since then the price of phenacetin has advanced a little and duties have been imposed.

There are many notable examples of medicinal chemicals awaiting a similar treatment by British manufacturers. For example, the barbituric acid derivatives, including veronal, luminal and adalin, and amidopyrin and antipyrin. It may be of interest to record the value of the imports of some of the items temporarily exempted from import duty because they are not manufactured in this country, in the hope that they will prove helpful to progressive manufacturers. The following figures come from the Board of Trade returns, and relate to the period January to September, 1932 (inclusive):

		£
Acetparaphenetidin	68,116 lb.	10,414
Adipic acid	20 cwt.	158
Amidopyrin	4,868 lb.	2,657
Bromural	234 lb.	242
Calcium gluconate	135 lb.	20
Chinosol	599 lb.	433
Diethyl barbituric acid	5,062 lb.	1,061
Dimethyl sulphate	117 cwt.	453
Diphenyl	32 lb.	22
Diphenyl oxide	2,072 lb.	210
Ethylene bromide	1 cwt.	15
Glycol ethers	472,434 lb.	23,753
Guaiacol carbonate	2,271 lb.	679
Hydroquinone	672 cwt.	14,665
Lead acetate R.	1 cwt.	2*
Metaldehyde	14 tons	2,103
Methyl cyclohexanol methyl adipate	42 cwt.	264†
Methylene chloride	1,577 cwt.	3,320

Methyl sulphonal	487 lb.	295
Nickel hydroxide	37 cwt.	599
Phenazone	12,846 lb.	3,665‡
Phenyl salicylate	39 cwt.	830§
Phloroglucine	80 lb.	334
Piperazine	—	—†
Potassium caustic R.	1,202 cwt.	3,857
Potassium chloride R.	83 cwt.	169
Potassium guaiacol sulphonate	45 cwt.	982
Potassium permanganate	420 cwt.	1,070†
Propionic acid	42 cwt.	4
Resorcin	24 cwt.	427§
Strontium carbonate	39 cwt.	36†
Strontium nitrate	—	—†
Sulphonal	1,750 lb.	958†
Urea	1,084 cwt.	3,748

* Figures for two months suppressed.

† Figures for one month suppressed.

The fermentation industries, including the production of citric and lactic acids, constitute a section of chemical industry so wide and varied as to call for separate treatment, nevertheless it should be here recorded with satisfaction that British manufacturers are offering a steadily increasing range of solvents of greatest value in fine chemical manufacture as well as in the preparation of dopes, plastics and the like. Several new higher alcohol esters, and benzyl cellulose, are now included among the substances prepared in this country.

Crystalline Vitamin D

Some of the most important advances in fine chemicals during the past year relate to the vitamins. The isolation of the first crystalline vitamin as a chemical entity took place a little more than a year ago, when vitamin D was prepared in pure crystalline form. Very shortly after the announcement of this discovery and the publication of the method of preparation by Bourdillon and his colleagues of the National Institute for Medical Research, crystalline vitamin D, or calciferol, was offered for sale in quantity by The British Drug Houses, and during the past year others have also undertaken the manufacture. The great importance of vitamin D is apparent when we consider that it is normally produced in the human body exposed to bright light in a clear atmosphere, but is not produced during the winter months in those who live mainly indoors, or whose lives are spent in smoky cities. Certain items of food contain it, notably milk and butter; most of the margarine sold is, however, free from it. Vitamin D is needed in the animal body to promote calcium and phosphate metabolism, the daily requirement of an adult man being of the order of 1,000 units. The extraordinary activity of pure crystalline vitamin D, or calciferol, as this is now named, is made apparent when we consider that one gram of it produces quantitatively the effect on metabolism which is brought about by 20 tons of summer butter, 0.25×10^{-6} gram daily sufficing to maintain calcification in a rat.

Calciferol is a stereoisomer of ergosterol. When ultraviolet light acts upon the latter several other isomeric substances are also produced. Windaus and his colleagues have made important contributions to this subject. They find that while two of these isomers present in irradiated ergosterol, namely, lumisterol and takisterol, exert no vitamin action, one of these, takisterol, exerts a definite toxic action. It is thus clearly advantageous to use the pure calciferol, in place of the previously used crude irradiated ergosterol. Although sold at a high price, calciferol is now the cheapest source of vitamin D.

Further Work on the Vitamins

Recent work on the purification of vitamin A prepared from halibut liver has resulted in the production of a concentrate of this vitamin having an activity comparable with that of calciferol. 0.1×10^{-6} gram of this active preparation was found to produce good growth in rats. The authors, Heilbron, Heslop, Morton, Drummond and Rea, having determined the physical properties of this concentrate, expressed the view that it is a nearly pure substance, and from their determinations of carbon and hydrogen they concluded that its formula was $C_{28}H_{30}O$. This vitamin can be readily esterified, and benzoate has been prepared and fractionally dis-

stilled in high vacuum. Ozone degradation results in the formation of geronic acid. The work of these authors is in close conformity with the publications of Karrer, Morff and Schopp.

The now well accepted view that vitamin A is formed in the animal liver from the hydrocarbon carotene, $C_{40}H_{56}$, present in the diet, has received much attention during the past year, all evidence being in support of it. In consequence, the Permanent Commission on Biological Standards of the League of Nations Health Organisation has recently adopted crystalline carotene as a standard for vitamin A potency. Daily doses of 3×10^{-6} gram of carotene, when administered to rats, are required to restore growth; since its activity is but one-fiftieth that of the purest specimens of vitamin A, it would thus appear that if carotene acts as a precursor of vitamin A it is only partially converted into vitamin A in the animal body. This may be due to its instability, or to its less ready absorption from the alimentary tract. Moore and others have shown that the vitamin content of liver can be built up to abnormally high levels by administering an excess of carotene or vitamin A in the diet. The livers of rats suffering from vitamin A starvation, on the other hand, become completely denuded of vitamin A in the course of time.

A recent publication by Szent-Györgyi of Budapest indicates the very high probability that vitamin C has now been isolated in pure crystalline form. The source of the vitamin used by Szent-Györgyi was the fruit of the Hungarian pepper, *Piper annuum*. The crystals which he separated were first described as a hexuronic acid, but Szent-Györgyi states that he has now renamed the substance ascorbic acid, and it is not a hexuronic acid. The antiscorbutic effect of his crystalline substance has been tested in many laboratories, and its high antiscorbutic property has been confirmed. Much criticism has been expressed concerning the work of Rygh and Rygh in identifying vitamin C with methyl-nor-narcotine; it therefore seems unlikely that Szent-Györgyi's claim will be disputed on this account. Grant Smith and Zilva have been unable either to confirm the antiscorbutic effect of methyl-nor-narcotine, or to find evidence of the presence of narcotine in unripe oranges.

Synthetic Chemotherapeutic Agents

Among new synthetic chemicals, outstanding interest attaches to the alkyl amino acridine derivative named Atebrin, discovered by the I.G. Farbenindustrie, the clinic trials of which have recently been reported. These show that the use of this drug in the treatment of various forms of malaria has met with very considerable success. It is therapeutically four times more powerful than quinine, and is more reliable than plasmoquine. Three daily doses are said to keep the patient free from malaria parasite for at least 34 days. The present indications are that quinine, plasmoquin and atebrin, either alone or in combination, will all have their particular sphere of usefulness in the treatment of malaria which, being so widespread and taking on so many forms, constitutes one of the very worst scourges to which mankind is subject. Both plasmoquin and atebrin have resulted from a definite attack of the organic chemist upon the problem of malaria, and progress in the laboratory has much depended upon the technique introduced by Roehl for studying the effect of substances upon artificially induced infection of avian malaria in birds. It has been a most brilliant piece of systematic study of synthetic compounds of the type of quinine, and reflects much credit upon the I.G.

Another outstanding example of German achievement in introducing new medicines is the successful use of tribrom ethyl alcohol in rectal anaesthesia, which now, many years after its introduction, is receiving wider recognition, as the technique of its administration has become better known. A study of the germicidal properties of various members of a homologous series led Boots Pure Drug Co. to the discovery of amyl meta cresol, and this substance is now coming into medical use.

Constitution of Hormones

Studies in the constitution of hormones have resulted in but little which has led to practical application or to new chemical identification. The isolation of the substance present in liver extract which is curative of pernicious anaemia has

not yet been accomplished, despite the early promise of Dakin and West's work. Evidence of a new hormone from liver has been given by Mapson, who has described a highly active preparation which accelerates growth in the rat, particularly in the male; the mere addition of this substance resulted in approximately doubling the rate of growth, and the growth response may be transmitted to the next generation through the mother. Work on the oestrous producing hormone has tended to a more general acceptance of the view that keto-hydroxy oestrin, $C_{18}H_{22}O_2$, is the true hormone, nevertheless the trihydroxy substance exerts a similar though less intense action. During the year much important work on the constitution of these substances has been published by Marrian, Doisy, Butenandt and many others, and it is by no means impossible that their constitution will be unravelled before another year has passed.

Work on the chemistry of insulin is slowly progressing. Jensen and Wintersteiner have recently shown that crystalline insulin yields glutamic acid in addition to the previously discovered amino acids which it yields on hydrolysis with hydrochloric acid.

Institution of Chemical Engineers

Further Increase in Membership

DESPITE the stringency of the times, the Institution can look back on a very satisfactory year's work and a still further increase in membership. At the annual corporate meeting, in February, Viscount Leverhulme was elected president, Mr. George Gray and Dr. W. H. Hatfield were re-elected vice-presidents and Mr. F. A. Greene and Mr. H. W. Cremer were re-elected respectively hon. treasurer and hon. secretary. The presidential address was on "Control of Industry," in which the retiring president, Mr. W. A. S. Calder, made many wise observations and gave stimulating advice to those on whom this responsibility is placed.

The Moulton medal for 1931 was presented at this meeting to N. E. Rambush and F. F. Rixon, for their joint paper, and the junior Moulton medal and prize to M. L. Nathan. The Osborne Reynolds medal was presented to H. Talbot, in recognition of his many services to the Institution since its incorporation.

In February the Institution sustained the loss of its first president, Sir Arthur Duckham, whose sudden and unexpected death came as a great blow to his many friends. The Institution owes much to his wise guidance during the time of its formation and in his term of office as president during the first two years of its corporate existence.

In July, Lord Leverhulme, on behalf of the Institution, unveiled a memorial tablet to the late Professor J. W. Hinchley, the first hon. secretary of the Institution, in the Garden of Rest at Golders Green. In addition, the Council decided to commemorate the close association of Professor Hinchley with the Institution by the establishment of a series of Hinchley Memorial Lectures, these lectures to be delivered every third year. The first of the series was delivered in October, before a large audience, by Mr. H. T. Tizard, Rector of the Imperial College of Science and Technology, who chose as his subject: "Chemical Engineering and the Aircraft Industry."

Papers read before the Institution during the year included:—"The Production of Hydrogen and Oxygen by Electrolysis at High Pressures," by Dr. D. M. Newitt and H. K. Sen; "Thermal Insulation," by Dr. Ezer Griffiths (at the Annual Corporate Meeting); "Coal Distillation in Rotary Retorts (Internally Heated)," by H. Nielsen; "Fluid Friction and its Relation to Heat Transfer," by Dr. C. M. White; and three papers on the testing of chemical plant, viz., "Functional Testing of Chemical Plant; some Theoretical Aspects," by A. L. Bloomfield; "The Testing of an Evaporator," by Professor W. E. Gibbs, and "The Theory and Practice of Testing Stills," by Dr. A. J. V. Underwood. Eight meetings were held by the Graduates' and Students' Section, under the chairmanship of Mr. K. Fraser. Mr. L. W. Blundell continued to act as hon. secretary of the section. There was a large and distinguished gathering at the president's reception, held on November 24 at Claridge's Hotel, over five hundred guests being received by the president and Lady Leverhulme.

A Review of the Solvents Industry in 1932

Hopes for a Wider Use of Lacquers

SOLVENTS, in common with most other commodities, have felt the effect of restricted trade conditions during 1932. Fortunately a large part of the solvents consumed is used for cellulose lacquers and since motor car bodies are nearly always finished with these lacquers, a comparatively active year in this industry has helped the solvents industry in a time of general difficulty.

With regard to new developments, the trading conditions during the year have not encouraged bold enterprise, consequently the industry has tended to adhere to established practice. Nevertheless a large amount of experimental work has been carried out and many new processes have been evolved, but these, appearing in an apathetic atmosphere, have failed to rouse sufficient interest to be given an extended practical trial. Among recent tendencies there can be discerned attempts to extend the use of lacquers in certain comparatively undeveloped fields, in particular for interior and exterior house decoration. The developments in this direction have been along two main lines. With regard to interior decoration, spraying lacquers possess certain disadvantages as compared with brushing lacquers, in that they require an expert manipulator with a battery of implements; further, the spray gun is not very convenient for complicated work where much stopping off is called for. Several attempts are therefore being made to produce a satisfactory brushing lacquer. This in its turn demands special solvents to ensure good workability of the lacquer and freedom from the disadvantage of raising an existing paint or lacquer film. With regard to exterior decoration, difficulties here are chiefly due to the poor adherence of cellulose lacquers on wood exposed to weather changes. In this field, the choice of plasticiser is important. In spite of difficulties inherent in this kind of work, some progress is being made, but it cannot be said that the methods evolved have had very extensive practical trial.

Production of Methanol

The synthetic process of manufacture of methanol has not undergone any marked changes. The existing plant, at any rate in this country, is more than sufficient to satisfy the home market and attempts are being made to find further outlets. One suggested use was as an addition to motor fuels in place of industrial ethyl alcohol, but in this connection methanol has certain disadvantages, chiefly with regard to miscibility, which seems so far to have prevented any important development in this field. The chief outlets are still for the denaturing of industrial alcohol and as a raw material for the manufacture of formalin.

During the year the chief new features in alcohol manufacture have been the increased interest in absolute alcohol and the development of new synthetic alcohol processes. In France alcohol-petrol mixtures have been quite extensively used in the past. It was important in that country to find outlets for superfluous alcohol, since it is an indigenous product and its consumption is bound up with the agricultural policy of the country. Recently, however, mixtures of petrol, benzol and alcohol have shown such marked advantages over petrol and petrol-benzol mixtures that a demand is rapidly being created in France for the petrol-benzol-alcohol mixture on its own merits. The rapid developments in such a field which seem to be extremely likely to take place in the near future will inevitably raise very great difficulties with regard to the supply of sufficient alcohol.

Synthesis of Alcohol

This difficulty has in its turn raised considerable interest in new methods of synthesising alcohol to meet the possible new demand. The Chemical Research Laboratory at Teddington is investigating the synthesis of alcohol from CO and H_2 and has so far obtained only moderate success. Keeping in mind the enormous quantities of alcohol which may be required, any process will be very severely handicapped if it produces appreciable amounts of by-products, since a market will have to be found for large quantities of these, and this is probably the chief drawback of the CO and H_2 synthesis. A large number of investigators are working on the synthesis from

ethylene which in case of need can be obtained in almost unlimited amounts by cracking petroleum. This synthesis at present shows more promise than the water gas synthesis, since it is not so liable to produce large amounts of by-products. During the year several patents have appeared claiming good results on a small scale by the direct combination of ethylene and water, using special catalysts. The process utilising the absorption of ethylene in sulphuric acid is still operating on a manufacturing scale, especially where a use can be found for the dilute sulphuric acid obtained as a by-product, for example, at coke ovens where ethylene is obtainable and the waste weak sulphuric acid may be utilised for ammonium sulphate manufacture. At present absolute alcohol is available at a price very little higher than the usual 95 per cent. spirit, but although it is a better solvent in most cases, its use does not appear to be extending very appreciably outside the motor fuel industry.

Iso-propyl Alcohol

Iso-propyl alcohol is being manufactured by the hydrogenation of acetone, but in only comparatively small amounts. It is used to some extent to replace ethyl alcohol in perfumery, being cheaper than alcohol, since it does not carry such a high duty. It has also been recommended as a denaturant for industrial spirit and, since it is almost impossible to separate it from alcohol by distillation or other simple process, it should be, therefore, an ideal denaturing agent. No doubt, if an important use were found for this product, it would be made cheaply from oil cracking gases.

In England synthetic acetone made by passing alcohol vapour and steam over an iron catalyst has firmly established itself. It is a high grade product comparing favourably with the fermentation product, and much better than the wood distillation product. Abroad, however, the butyl-acetone fermentation process seems to be extending and some recent improvements suggest that in future an increasing proportion of molasses will be used in place of the more expensive maize as a raw material. Unfortunately the fermentation process produces butyl alcohol and acetone in a fixed ratio and this is its chief economic drawback. Acetone is still extensively employed in spinning acetate silk and although methyl acetate has been suggested as a substitute it does not seem to have made very material progress.

Butyl Alcohol

The synthetic process used by British Industrial Solvents for the manufacture of butyl alcohol has become firmly established and produces a high quality product, suitable as a solvent and for ester manufacture. Abroad, a good deal is produced by the butyl-acetone fermentation and the same comments apply in this case as in the case of acetone.

Little change is discernible in the use of esters as solvents. Among the low boiling solvents ethyl acetate still seems to maintain its popularity. The continuous azeotropic process used by British Industrial Solvents is now well established and gives high yields of almost chemically pure ester. A cheap low boiling solvent consisting of a mixture of absolute alcohol and di-ethyl acetal has recently been tested but has not yet been used to any great extent.

Among medium and high boiling solvents butyl alcohol as a blusht preventer and butyl acetate as a solvent still hold their own as the most popular solvents for cellulose lacquers, followed closely by amyl acetate. Many users change from butyl to amyl acetate, according to the market price, using whichever is the cheaper. A substitute for the usual solvent mixture of ethyl and butyl acetates consists of a mixture of paraldehyde and absolute alcohol, but this, though much cheaper and a good solvent, has aroused little interest. With regard to the diluents benzene and toluene, which have the reputation of being somewhat toxic, suggestions have been made to replace these by di-ethyl acetal and paraldehyde respectively, and although these substances are more expensive they are probably less toxic and have the great advantage of being latent solvents.

New synthetic methods for preparing higher ketones are being tried out on a laboratory scale, but so far no appreciable

amount of these solvents is appearing on the market. The supply of "ketol" seems now to have dried up.

The tendency towards brushing lacquers mentioned previously has raised the question of a suitable high boiling solvent. The cellosolve type of solvent has many advantages, such as suitable volatility, freedom from odour, and compatibility with the underlying finishes. Recently, however, butyl lactate appears to be entering this field with some prospect of success. It confers good brushing properties and has most of the advantages of the cellosolvents, with certain advantages of its own. A development in brushing lacquers would almost certainly mean a considerable increase in the production of butyl lactate.

Synthetic Acetic Acid

Synthetic acetic acid produced by the oxidation of acetaldehyde accounts for the bulk of the acetic acid produced in this country. The acid is high grade and suitable for the manufacture of esters and cellulose acetate. The two processes which seem to have established themselves both use acetaldehyde as an intermediate product. In one process the acetaldehyde is produced from calcium carbide and in the other from ethyl alcohol obtained by fermentation. The acetaldehyde is then oxidised by means of air. Fermentation processes for the production of acetic acid from molasses have been worked out on a semi-industrial scale but have not yet reached the production stage.

Although strictly speaking higher alcohols do not come within the range of solvents, they are sufficiently closely allied to justify a passing mention. Alcohols of the acetyl type are finding increased favour as raw materials for new soap-like substances, which have all the advantages of soap, except perhaps cheapness, and none of its disadvantages. These are being made by extraction from whale oil in which the higher alcohols exist as esters, or by the catalytic reduction of the corresponding fatty acids. There seems little doubt that the future will see big developments in this direction.

Plasticisers

Among plasticisers di-butyl phthalate is still the most popular for nitrocellulose lacquers, but tri-cresol-phosphate is beginning to compete with it for popularity. Sipalin and barkite also seem to be finding some favour. New plasticisers for cellulose acetate are continually arising, but nothing has so far appeared on the market which confers such desirable properties on cellulose acetate as camphor does on celluloid or di-butyl phthalate on cellulose lacquers.

Ester gum for cheap lacquers and dammar for high class lacquers are still the most popular resins. The rezyls are, however, creating much interest since they have useful characteristics. Research in this field has been extremely active but the products have been for the most part intended for use with the drying oils.

The Chemical Society Widens Its Scope Development During the Year

DURING 1932, the Council of the Chemical Society has taken important steps to widen generally the scope of the Society's activities and, in order that Fellows resident in the country may be more closely associated with the affairs of the Society, has appointed 17 local representatives resident outside London by whom it will be advised on all matters concerning the Society. It has arranged for an adequate proportion of the endowed and special lectures, which hitherto have been given in London, to be held in the provinces; in accordance with this decision, the Fourth Liversedge Lecture entitled "Physical Atomic Weights" was delivered by Dr. F. W. Aston at Birmingham on November 25, and the Ostwald Memorial Lecture will be given by Professor F. G. Donnan, in the Chemistry Lecture Theatre of the University of Liverpool on January 27. These and other meetings outside London which are to be devoted to lectures or discussions of a general character are held under the direct auspices of the Society and in close co-operation with existing chemical organisations in the various centres; the council welcomes at these meetings the presence of all those interested. The Third Pedler Lecture entitled "The Life and Work of Otto Wallach" was delivered by Professor L. Ruzicka on March 10, the fifteenth Faraday Lecture entitled "The Relations between Stereochemistry and Physics" will be given by Professor Dr. P. Debye, in the lecture theatre of the Royal Institution on March 29, 1933, and the Sixth Hugo Muller Lecture, entitled "Chemistry at the Cross Roads" by Professor H. E. Armstrong, in the meeting hall of the Institution of Mechanical Engineers, on May 25, 1933.

Fourteen Scientific Meetings

The reading of highly specialised papers at the ordinary scientific meetings has been restricted, the secretaries being empowered to select papers for reading and to invite Fellows to take part in the discussions. During the year, 14 ordinary scientific meetings have been held, of which three have been devoted to the following discussions; "Some Aspects of Asymmetric Synthesis" opened by Professor A. McKenzie; "Combustion of Gases in Electric Discharges" opened by Professor G. Ingle Finch, and "The Chemistry of the Sterols and Bile Acids" opened by Professor I. M. Heilbron. Two further discussions have been arranged, one on "The Raman Effect in Relation to some Chemical Problems," to be opened by Dr. J. J. Fox on February 16, and the other on "The Chemical Constitution of Oestrin," to be opened by Dr. G. F. Marrian on March 16, 1933.

The Society held its anniversary meetings this year at Glasgow, and was accorded a civic reception by the Lord Provost and the Corporation on March 17. The 91st annual general meeting was held in the University of Glasgow the following day, when the president, Professor G. G. Henderson, delivered his presidential address entitled "The Publication of Chemical Literature," the anniversary dinner taking place the same evening at the Grosvenor Restaurant, and on March 19 visits were made to Nobels explosives works at Ardeer and to the Provan chemical works. The next anniversary meetings will be held in London on March 30, 1933.

An extraordinary general meeting on December 16 the Council was given power to reduce (by not more than one-half) the annual subscription payable by any Fellow under 25 years of age who is willing to forego the receipt of such of the publications of the Society as the Council may determine.

The Society's Publications

The annual reports for 1931 (issued in February) contained in addition to the usual reports a biennial report on Crystallography and special reports on Covalency and Colloid Chemistry, and the volume for 1932 (to be issued in February, 1933) will contain the usual reports and biennial reports on Geochemistry and Radio-Activity and Sub-Atomic Phenomena. The Perkin Memorial Volume dealing with the life and work of the late Professor W. H. Perkin, and the Discussion Number of the Journal on "The Critical Increment of Homogeneous Reactions" were issued in January, free of charge, to Fellows and on sale to the public.

Eighty-three applications for research grants, representing £902, were received and grants amounting to £729 were distributed to 78 applicants. The sum applied for each year far exceeds the amount available for distribution and prior claim is given to applications received from Fellows of the Society. The use of the library steadily increases, and the number of volumes in the library, exclusive of pamphlets, is over 36,000. The library is open from 10 a.m. to 9 p.m. (except on Saturdays when it closes at 5 p.m.) and is used by Fellows of the Society and members of the Association of British Chemical Manufacturers, the Biochemical Society, the Faraday Society, the Institute of Brewing, the Institute of Chemistry, the Society of Chemical Industry, the Society of Dyers and Colourists, and the Society of Public Analysts, which contribute to its upkeep.

Financial Position of the Chemical Industry

By S. HOWARD WITHEY, F.C.I.

(Senior Fellow of the International Accountants' Corporation)

THE past two years have been characterised by falling prices of chemicals and allied products, and industrial and engineering operations have been greatly retarded by diminished purchasing power on the part of buyers, and also by heavy taxation and the need for allocating considerably greater sums to cover depreciation of plant and equipment. For the most part, directors have been compelled to pursue a conservative policy in the matter of dividends, with the result that the financial strength of the leading companies has been well maintained. Costs of production have been reduced in most sections, and those firms whose business is world wide confidently await the return of stable prices and exchange rates which cannot be much longer delayed. Keen competition to secure the relatively small volume of business available is reflected in the almost universal drop in profit margins to the lowest figures for many years, but there are many indications that the bottom of the depression has been reached, and that British industry as a whole has successfully weathered the storm.

Copper and Tin Interests

For the most part the manufacture of copper and brass sheets, tubes, etc., in Birmingham and the adjacent districts has been on a much smaller scale than usual, and many firms have sustained losses or have realised a smaller margin of net profit. In the case of Charles Cliford and Son, Ltd., the figures submitted in the early part of the year disclosed a net profit balance of £6,068, which figure compares with £11,743 realised during the preceding twelve months, and although a final dividend of 5 per cent. was paid on the ordinary share capital, making 10 per cent. for the year, the tax-free bonus of 5 per cent., which had been a feature of the ten previous distributions, was dropped, while no transfer was made to the machinery reserve. This company was registered in 1887, the authorised share capital being £90,000 in £1 shares, all of which have been subscribed and called up, comprising £30,000 in the form of 6 per cent. cumulative preference shares, and £60,000 in ordinary shares.

Smelters and refiners of copper and tin with works in Staffordshire, Lancashire and Dorset, as well as manufacturers of copper and brass tubes, sheets, plates, wire, turbine blading, etc., in these areas, have been greatly handicapped by deplorable conditions, and although a profit of £31,944 was realised by Thomas Bolton and Sons, Ltd., during the financial year ended March 31 last, it was found necessary to allocate £11,734 to the retirement compensation account, and to utilise £16,000 for the adjustment of base metal values, with the result that after meeting debenture charges a credit balance on profit and loss account was converted into a debit to go forward to the next account. In common with other ironfounders, Stewarts and Lloyds, Ltd., reported a sharp decline in profit, and after adding dividend income and providing for directors' fees and income tax, and debiting £150,000 under the heading of depreciation the net figure came out at £167,272, which was considerably less than the balance shown in previous accounts. No dividend was paid on the deferred shares, the carry forward being slightly increased to £137,119.

Galvanised Iron Products

Business during the past year in galvanised iron products and in aluminium equipment for the chemical and allied trades has been fair, the general position in this department of activity being reflected in the declaration by the directors of Frederick Braby and Co., Ltd., of a dividend of 2½ per cent. for the year ended June 30 last, as compared with 7½ per cent. for the preceding twelve months. Steel pipe manufacturing firms managed to escape the worst effects of the general depression, but falling prices and acute competition limited profit margins. For the financial year to June 30 last the Staveley Coal and Iron Co., Ltd., reported a profit of £219,280, as compared with £286,130 for 1930-31, the dividend being reduced from 6 per cent. to 5 per cent. and a smaller sum transferred to reserve, leaving the carry

forward at much the same figure, but reduced output on the part of the Consett Iron Co., Ltd., resulted in a loss of no less than £88,007, after meeting debenture interest, this amount being deducted from the balance brought in from the previous account, resulting in a credit of £149,726 to be carried forward.

The leading manufacturers of sulphuric acid, hydrochloric acid, zinc chloride, liquor ammonia and red lead have been able to hold their own in the teeth of fierce and not always fair competition, and the final accounts of the Chemical and Metallurgical Corporation, Ltd., revealed an increase in the balance of net profit, thereby reducing the debit to go forward. On the other hand the production of acid-resisting and non-corrodible iron alloy at a profit has been extremely difficult, and it was not surprising that a net loss was sustained by the Lennox Foundry Co., Ltd., which company has not yet been able to declare a dividend.

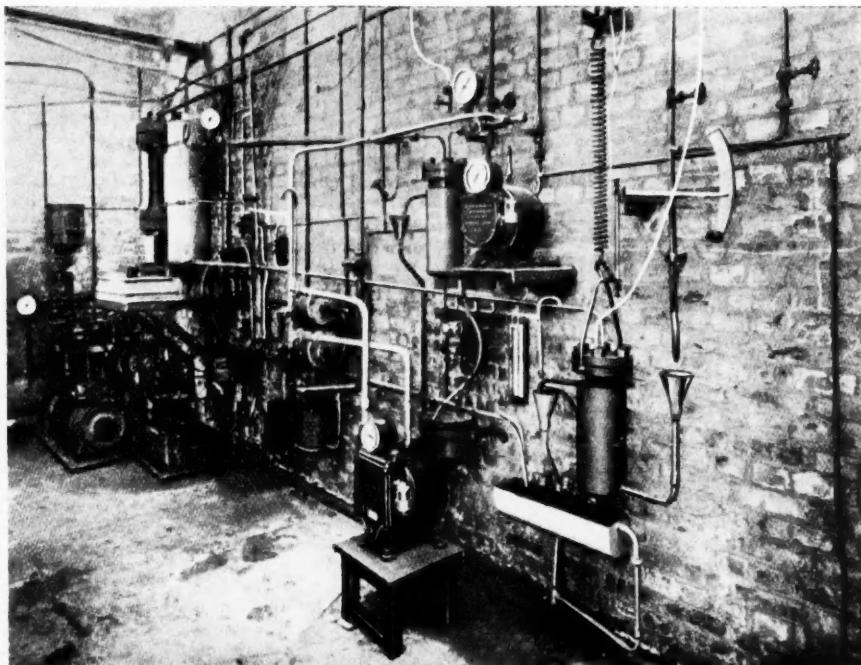
Fine Chemicals

In the pharmaceutical products and fine chemicals section, the fall in values was reflected in substantially reduced earnings. British Drug Houses, Ltd., for example, realised a gross profit of only £36,381, as compared with £58,086 previously, and after making adequate provision for the amortisation of leasehold properties, and charging depreciation, directors' fees and income tax, the net profit worked out at £17,049, or a decline of no less than £22,953. No dividend was paid on the ordinary share capital, and only £3,000 was transferred to reserve as compared with £10,000 in the preceding year. In the case of Boots Pure Drug Co., Ltd., however, a satisfactory increase in net profit was reported for the twelve months ended March 31 last, the figure being £731,891, as compared with £722,264, and the ordinary dividend was accordingly maintained at the rate of 29 per cent., of which 5 per cent. was tax free. Registered in 1888, Boots Pure Drug Co., Ltd., has an authorised share capital of £2,000,000, all of which has been issued and paid up, consisting of £10,000 in 7 per cent. cumulative "A" preference shares; £25,000 in 6 per cent. cumulative "B" preference shares; £100,000 in 6 per cent. cumulative "C" preference shares; £120,000 in 7 per cent. "A" preferred ordinary shares; £245,000 in 7 per cent. "B" preferred ordinary shares; £400,000 in 7 per cent. "C" preferred ordinary shares; £500,000 in 7 per cent. "D" preferred ordinary shares; and £1,500,000 in ordinary shares.

Enamelled Metal Products

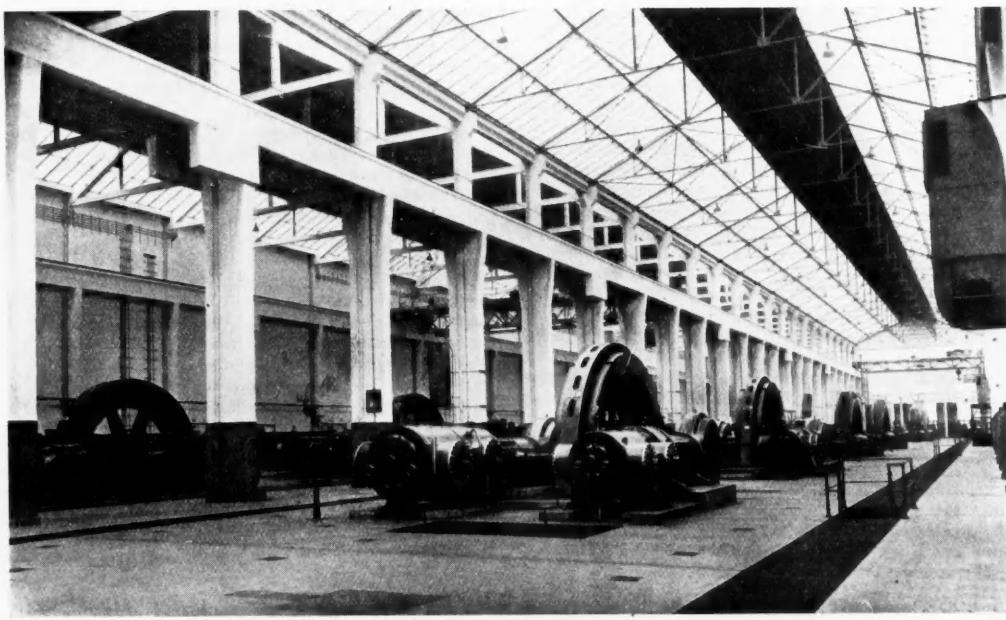
Trade in glass enamelled steel tanks has not been very profitable, and the audited accounts of the Enamelled Metal Products Corporation, Ltd., covering the financial year to April 30 last, disclosed a net loss of £2,767, which compares unfavourably with the profit of £5,133 realised during the previous accounting period. No dividend was possible, and a credit balance of £707 was carried forward to the next account as against £3,487 brought in. This corporation was registered in 1907, the authorised share capital being £100,000, of which a total of £83,005 has been subscribed, but only £49,672 paid up. In the pottery section, substantially reduced profits have been realised, and Doulton and Co., Ltd., reported a credit balance of £4,835, as compared with £57,964, only the preference dividend being paid and a greatly reduced sum carried forward.

The results reported by Imperial Chemical Industries, Ltd., were better than had been expected, the gross profit for the year being £4,668,685, or a decline of approximately 9 per cent. After debiting income tax, and allocating £1,000,000 to the company's central obsolescence fund, the net profit was shown at £3,408,290, as compared with £4,473,392 realised during the preceding twelve months. The rate of ordinary dividend was reduced from 6 per cent. to 4½ per cent., the deferred shares only ranking for dividend after 7 per cent. has been paid on the ordinary. The company's holding of securities increased but no definite provision was made against abnormal and temporary depreciation.



New Prospects for Low Temperature Tars

The problem of finding markets for the tar produced by low temperature carbonisation is receiving active attention. Whilst petroleum is available at a low price, the direct use of tar and tar products as fuel oil cannot be a profitable outlet. The hydrogenation-cracking of tar, however, may open up new possibilities. The experimental plant illustrated was built at the Fuel Research Station, East Greenwich. It is designed for the continuous treatment of 5 gallons of tar per day, at a pressure of 200 atmospheres and temperatures varying from 450° to 490° C.



Synthetic Ammonia for Fertiliser Manufacture

For the synthesis of ammonia at the works of the Compagnie Néerlandaise de l'Azote, at Sluiskil, in Holland, the Fauser process has been chosen. This installation is said to be the largest Fauser plant in operation. In the compressor house shown above, the gaseous mixture of nitrogen and hydrogen is dealt with at the rate of 6,000 cubic metres per hour. In contrast with other low pressure processes the Fauser system uses an activated iron oxide catalyst, which has been found to require renewal once a year. The total capacity of the plant is 200 tons of ammonia per day.

Developments in Plastics

By H. V. POTTER, B.Sc., F.I.C.

IN this country the plastics industry is now ably represented by the British Plastics Moulding Trade Association and the Plastics Institute, both of which have shown considerable activity this year. During the year the Plastics Group of the Society of Chemical Industry was formed of which group I have the honour to be the first chairman. Some criticism has been levelled at the Society in connection with this action, particularly on account of the very able and useful contribution of the past-president, Professor Morgan, on the subject of unification of technical societies. The action of the society, however, was, in my opinion, quite in accord with the past-president's views since the formation of this group within the society had the possible effect of preventing the chemists and chemically minded technicians in the industry from grouping together to form a separate association of their own since neither of the two existing bodies, the Trade Association or the Plastics Institute could be expected to cater for the purely chemical interests of this new industry.

Patent Literature

Patent literature has continued during the year without abatement covering a few new types of plastics, modifications of existing types and application in particular fields for existing plastics. The older types such as celluloid, casein and natural resins have ceased to attract in the same way as the newer types such as the phenol-formaldehyde, urea-formaldehyde and more recently the cellulose ester and ether types. The nitro-cellulose plastics, such as celluloid, have possibly ceased to hold the lead in tonnage production owing to the growth of the newer types. The world production in 1930 was 40,000 tons, but for the year 1932 it is possibly only about 60 per cent. to 70 per cent. of these figures on account of the trade depression of which Great Britain accounts for about 10 per cent. This class of plastics has steadily progressed and is still finding new applications along well defined lines where inflammability is not a serious drawback. The finish, appearance and colour effects are still being improved and extended. Its use in safety glass has been hampered by the tendency to darken in colour.

The natural resin plastics, of which shellac is the largest ingredient, have unquestionably had a serious setback on account of the quiet state of the gramophone record industry. In spite of this, however, it is probable that it is the second largest class of plastics in the country. In 1929 the gramophone record industry was using about 20,000 tons of plastics. It is doubtful if this year it will use as much as 15,000 tons. A large amount of work has been done on flexible records with the object of getting away from the use of shellac on account of the un-table price position of this material, and producing a record lighter in weight. So far the shellac record has not yet come up against a real rival in this respect on account of a number of technical and reproduction difficulties. There is one record available, however, in which a thin layer of resorcinol-formaldehyde resin is applied to the surface of treated paper and this has met with some success. Efforts to find a substitute for actual shellac have not so far made much headway. Most of the development work in this direction has been with the phenol-aldehyde type and several patents have been taken out covering the production of this class of resin as a substitute for shellac but with only limited success.

The Natural Resins

The natural resins such as shellac, copal, kauri and collophony, along with tung oil and other ingredients, namely, bitumen, continue to be used for the production of small moulded insulations where finish is not important or price rules out other types. The very cheapest type of pressed or moulded insulation is usually compounded of these products. They should not be strictly referred to as moulded articles as they are usually stamped out of the warm plastics sheet by power presses and then baked for varying periods to harden afterwards. It can be appreciated that this method of production does not lend itself to good finish and appearance. The newer types of plastics moulding powders have ousted this class in many fields, but where high heat resistance is required on that occasion for outside insulation such as strain insulation, telegraph and telephone pole insulation, they still

have an extensive application chiefly on account of price. The casein plastics, judging from results of one individual company which has had very successful results during the year, continues to find extended applications chiefly for decorative purposes. It has almost entirely replaced horn or bone and one has only to look at the catalogue of the fancy department of the average stores to see how extensively this class of plastic supplies the wants and taste of the average customer. The combination of casein with other plastics such as phenol-formaldehyde resins has been successfully tried and such a product has found practical although limited application.

Synthetic Resin Plastics

The synthetic resin plastics can still claim the honour of topping the list in number of patents taken out during the year, although the applications have shifted from the older, that is the phenolic type, to the newer, that is the urea, thiourea, glyptal and styrol types. The phenol-aldehyde resin plastics still represent the largest output of this group in tonnage production while the synthetic resin group can, I believe, claim second place in total tonnage production during 1932. It is reasonable to assume that in spite of the trade depression the tonnage used of the phenol-aldehyde type this year has never been larger in any previous year in this country. It is estimated that the increase is about 20 to 25 per cent. above the year 1931. The more recent developments of this class of material have been the field of air drying varnishes as protection coatings. While they have certain drawbacks in respect to light resistance, their resistance to moisture and sea air is a great advance on any other type of resin finish. Judging by the patent literature, investigations are following the lines of maintaining their valuable resistance to weather but overcoming the darkening to light. The application of this class of synthetic resin into the abrasive wheel industry has enabled peripheral speeds of grinding wheels to be attained which have not been possible before. High speed snagging and cutting by abrasive wheels is only in its infancy in this country, but in the United States very large developments have taken place in recent years along these lines and this country is only waiting for the industrial revival to install the special machines which are necessary for running at high speeds.

Resinoid Mouldings

The largest application for the phenol resinoids and the urea resinoids consists in the field of moulding. This development still continues unabated into new fields of application and it is difficult to find an industry into which synthetic resinoid mouldings have not obtained a footing. Some of these are the toy industry, constructional, building, decorative industries, electrical, engineering and packing trades, to mention only a few. Glyptal resins made from glycerol and phthalic acid have been slow in their development until the last year or two but are now finding extensive application in the paint and enamel industry. For this application the resin or its ingredients are usually reacted with tung oil to give a relatively pale resin which is oil soluble and has the advantage of permanence to light while showing good resistance to weather. They have proved to be a useful addition to the resinous ingredients available for paint and enamel manufacture and enables the ever-increasing demand for faster drying finishes to be met. Apart from this application, and these resins are useful as a bonding material for micanite sheet and tube insulation, they have not shown any marked development in other direction so far. This may be on account of the slowness with which they are converted to an insoluble and infusible stage. There does not appear to be any relatively sudden chemical change from the fusible to the infusible state comparable with the phenol or amino resinoids the change being gradual over a prolonged period and most likely involving a continuation of the metal reaction, and not a second chemical reaction such as takes place with the phenol type.

The urea and thiourea formaldehyde resins referred to as "amino resinoids" have continued to attract investigators, technicians and industry during the year. They have their

field of usefulness which at present lies particularly around their decorative value. They are not darkened by light and are practically water white in contrast to the phenol resinoids. They have drawbacks in other directions, however, and their higher affinity for moisture renders them less suitable for insulation. Their general domestic use has been deterred by the inherent weakness of human mortals not to tolerate their tea or coffee in any other vessel than those made of a ceramic material except under unusual circumstances such as at a picnic. The use of amino resinoids moulded ware has, however, become quite general on these special occasions where formality is set aside and has certainly added to the amenities of mankind. Some work has been done on combining these resins with other types such as the phenol resins to render them more water and moisture proof but without serious success so far. Development in the field of laminated decorative sheet has been carried on and one British company, much to its credit, supplied some of the wall decorations for the studios at Broadcasting House in sheet form in a very delicate colour which is not possible so far in any other type of synthetic resinoid. If the amino plastics could be rendered more weather resistant or the phenol resinoids more light resistant than the future possibilities of these materials would be increased many times.

Cellulose Plastics

The last, but not by any means least important group of plastics, are the cellulose ethers and esters which may be spoken of as "cellulose plastics." I have already referred to celluloid which falls into a class of its own; the others are cellulose acetate and benzyl cellulose plastics. Both these products, by incorporation of suitable plasticisers, soften under heat and pressure and are of the thermo-plastic but not thermo setting type such as the phenol, amino or glyptal plastics. They therefore, must essentially be handled by the ordinary method for such plastics, that is by pressing hot and cooling before ejection or by a special method which has been derived recently called "injection" moulding. In this process the cellulose plastic is placed in a closed steam jacketed cylinder, with a plunger at one end and a fine nozzle at the other to which the mould containing the desired shape of the finished article is attached. The material while hot and plastic is forced into the mould under pressure, the latter being kept cool. The nozzle is then closed and the mould opened and the moulding ejected in its finished state. This method of production of mouldings is very quick, and the equipment relatively inexpensive but until the cellulose plastics can be manufactured cheaper the application is limited to special uses where other plastics cannot be used. There is, however a great possibility for this type of moulding and new developments may be looked for.

Having surveyed the relative merits of the main materials under the generally accepted term "plastics" it would perhaps be fitting to give a few remarks on the general position with some reference to the possible trend in the future. In a recent address of mine it was stated that the plastics industry probably represented a tonnage production of 25,000 tons per annum. This was not intended to include the moulding industry, whose function is to convert plastic material, particularly of the phenol or urea resinoid type, into finished articles but only the weight of actual plastic materials manufactured irrespective of products made therefrom. It is likely, however, that for the whole of this year the tonnage production of celluloid plastics, casein, synthetic resins, cellulose and natural resin plastics, will amount to approximately 30,000 tons.

The Future of the Industry

The number of patents granted in this country for 1932 covering the manufacture or application of plastics, already exceeds 290 to date so that it may be assumed that for the year 1932 they will be in the region of 300 thus representing about 1.5 per cent. of the total number of patents granted. This again emphasises the great activity that is going on in the technical development of these materials. The industry, like many other relatively new ones, has in many ways followed existing practice and methods in its development: in other words the "line of least resistance." The manufacture of plastics is essentially a chemical industry and has thus followed in most cases routine chemical methods of manufacture. I think I can justly say that practically all

the processes are what are termed "batch processes" in which existing types of chemical equipment have been used with modifications to meet special requirements here and there. The processes generally do not adapt themselves readily to continuous production but it is along these lines that future developments show most promise.

The utilisation of plastics in various other industries is more allied to engineering than chemistry. On this side more ingenuity and development along specialised lines have been shown. While the hydraulic press has been available for many years the type and construction and general layout has been radically changed to meet the needs of the plastic moulding industry. There is, however, room for more development on the lines of continuous operations to cut out the large amount of handling that is still required. Speaking generally, the moulding material in a finished article in plastic only represents about 25 per cent. to 30 per cent. of the total cost, labour represents about another 30 per cent. to 50 per cent. so that there is ample scope for reduction of labour costs to reduce total costs of or moulded articles in plastic materials. There has been very little real novelty in design of finished plastic products. The industry has grown so rapidly that plastics in most instances have only substituted some other material. The past rate of development cannot be expected to continue on these lines.

Plastics can now be obtained in so many forms and colour. Celluloid in sheet and moulded casein likewise is procurable in very beautiful colours. Synthetic resinoids are available in every conceivable type of moulding of dark, warm hues to pale colours, transparent or opaque, in sheet form for paneling, constructional, electrical and mechanical uses, while the cellulose plastics show promise of development into channels where the others cannot reach such as for pens, pencils, small articles in colour effects quite characteristic of their own.

Federal Council for Chemistry Probable International Meeting in 1934

THE objects of the Federal Council for Chemistry are to foster and advance the scientific interests of chemistry in all its branches and to that end (1) to represent the views of British chemists both nationally and internationally; (2) to co-operate with those bodies in Great Britain and the British Empire representing the science of chemistry and to co-ordinate their scientific activity and (3) to enter into scientific relations and to co-operate with similar bodies in other countries and, in particular, to act as the representative of the British Associations of Chemistry in the International Union of Chemistry. The council consists of representatives appointed by each of the constituent organisations and associated bodies, and of such other members as the council may from time to time elect. The constituent organisations and associated bodies are those concerned wholly or in part with the advancement of chemical knowledge and its dissemination in all countries.

At a meeting of the Bureau of the Union Internationale de Chimie held in Paris on January 22, 1932, it was decided, in view of the world-wide situation, to postpone until a more favourable time the ninth International Congress of Pure and Applied Chemistry, which was to have been held in Madrid from April 3 to 10, the object of the congress being to further the progress of pure and applied chemistry and to strengthen relations between chemists the world over. The eleventh conference of the International Union which was to be held in Madrid at the same time, has also been postponed, and it is hoped that conditions will permit of these two meetings being held in Madrid some time in 1934. The Bureau of the Union Internationale has been given authority to exercise the powers of the Council until the next meeting of the Union. The Verin Oesterreichescher Chemiker and the Svenska National Kommitten für Chemie have been admitted members of the Union Internationale.

Mr. Emile Mond, hon. secretary, represented the Federal Council at the Douzième Congrès de Chimie Industrielle held at Prague in September. Matters which have occupied the attention of the Federal Council include the standardisation of methods of analysis of essential oils and fixing standards of quality, standardisation of methods of water analysis, the questions of organic nomenclature and of biochemical nomenclature, the unification of chemical abstracts and chemical documentation.

The Nitrogen Industry in 1932

By E. B. MAXTED, D.Sc., Ph.D., F.I.C.

THE progress of manufacture and of original work in the nitrogen field during the past year has necessarily been affected by factors which are common to all branches of industry; and, while the potential market for fixed nitrogen, given normal times and adequate education of possible nitrogen buyers, cannot be regarded as being by any means fully covered even by the huge existing nitrogen fixation plants (and this view is reflected by the apparent policy of the various nitrogen syndicates), the nitrogen problem has, as has also been remarked by H. A. Curtis (1), become rather the finding of markets for available supplies than the further development and extension of the industry. Not the least of the factors which are dominating production is the low level of the prevailing world prices. Thus, ammonium sulphate, partly owing to free competition, was being sold for export during June at as low a price as £4 5s. a ton. Yet, in spite of these low prices, the total quantities of all varieties of nitrogenous fertilisers sold during the year have considerably decreased, this movement being due to world poverty and being in spite of the low price and the agricultural desirability of the products available. Some of the papers and patents which have appeared during 1932 are here classified and summarised.

Synthesis of Ammonia

Dealing first with the manufacture of the constituent gases, A. Mentzel (2) has described a special cell and procedure for the preparation of hydrogen by electrolysis under pressure, the hydrogen being heated, to remove traces of oxygen, before being mixed with nitrogen. Pressure electrolysis has also been discussed by D. M. Newitt and H. K. Sen (3). The subject is of considerable general interest in view of the deflection of water power from other methods of nitrogen fixation to the production of hydrogen for the synthesis of ammonia, as an alternative to its manufacture from fuel, either by the low temperature separation of coke oven gas or by the catalytic interaction of carbon monoxide with steam. For proposals for the direct preparation of the nitrogen-hydrogen mixture from fuel, reference may be made to a patent of the Interessengemeinschaft (4). The process is one of complete gasification with air, followed by the reaction of the resulting gases with steam under conditions for which the original specification should be consulted.

Purification of the gases from carbon monoxide, by conversion of this into methyl alcohol, has received attention in a specification of A. T. Larson (5). The gas is treated with a catalyst of the zinc-copper-chromate type at a pressure of 100 atmospheres and at a suitable temperature between 300 and 600° C. In a further specification (6), a copper-manganese-magnesium-oxide catalyst is recommended. In view of the proportion of hydrogen to carbon monoxide required, the process obviously cannot be used for the direct elimination of carbon monoxide from the usual fuel gases, to give residual hydrogen suitable for ammonia synthesis; but it may well form a useful method of dealing with gas containing smaller quantities of carbon monoxide, such as result from the catalytic water-gas-steam process, in place either of absorbing this impurity or converting it, by hydrogenation in a pre-reaction vessel, into useless methane.

Procedure for purification from water vapour, of the type in which the gas is scrubbed with liquid ammonia under pressure, has been described by L. C. Jones (7). This method of drying may obviously be used after the usual purification furnace.

Ammonia catalysts have now become more or less standardised, and little that is novel has been suggested during the year. The proposal of the Society of Chemical Industry in Basle (8) to add to catalysts, in addition to the usual pro-

moters, small quantities of arsenic, phosphorus or boron is, however, of great interest in connection with the mode of action of catalyst poisons generally, since it has also been found that traces of poisons, if small enough in quantity, appear to act beneficially in the oxidation of ammonia (9).

For the elimination of ammonia from the circuit gases, the use of thallium trichloride, which forms a compound $\text{TeCe}_3 \cdot 18\text{NH}_3$ may be noted (10). This is reminiscent of the employment of cobalt compounds for a similar purpose, save that the latter can be used at a higher temperature. Finally, in spite of the apparently uneconomic aspect of the reversed process, attention is being given to the preparation of a mixture of nitrogen and hydrogen by the thermal decomposition of ammonia. Thus, R. L. Dodge and the Du Pont de Nemours Company (11) employ for this purpose a catalyst consisting of iron together with various alkaline earth promoters, and the subject is also treated in a specification of C. S. Hall and Imperial Chemical Industries (12).

Ammonium Salts

Several specifications deal with the formation of ammonium sulphate from sulphite or from mixtures of ammonia with sulphur dioxide. Thus Vorländer and Lainau (13) propose as a catalyst for the oxidation with air of ammonium sulphite solutions a complex cobalt compound produced by the action of oxygen and sulphur dioxide on a cobalt salt in ammoniacal solution; and H. J. Hodgeson (14) has suggested a process of oxidation with air in the presence of manganous, cuprous or ferrous salts, the oxidation being completed electrolytically. A further patent of W. C. Holmes and Co. and Hodgeson (15) is somewhat similar. The preparation of ammonium sulphate from waste gases from sulphur trioxide contact plants is described in British Patents 360,326-7 (16). These gases are led into saturated ammonium sulphate solution, whereby crystalline ammonium sulphate is precipitated and ammonium sulphite formed. The solution is then treated with sulphuric acid to form ammonium sulphate and concentrated gaseous sulphur dioxide, which is used in the contact plant.

For the formation of large sized ammonium sulphate crystals, compressed air may be expanded in an ammonium sulphate solution at the bottom of the saturator, when the cooling effect induces crystallisation (17) or, in the case of ammonium chloride, pectin may be added (18). H. Koppers A.-G. (19) suggest the passage of the ammonia, in an ammonium sulphate saturator, below the surface of the liquid in order to induce agitation. For further proposals for the preparation of coarse and of fine grained sulphate, reference may also be made to a specification of Collin and Co. (20).

The preparation of ammonium sulphate-nitrate may be carried out (21) by introducing ammonia and sulphuric acid into an ammonium nitrate solution under conditions such that the heat of neutralisation is used to evaporate the liquid. A further method of preparing the same salt by treating ammonium nitrate with ammonia and subsequently with sulphuric acid has been proposed by the Ruhrchemie A.-G. (22). A paper dealing with the hygroscopicity of ammonium sulphate (23) may also be noticed. This, in non-neutral sulphate, is stated to be proportional to the free sulphuric acid content.

- (8) Brit. Pat. 359,378.
- (9) J. Y. Yee and P. H. Emmett, J. Ind. and Eng. Chem., 1931, 23, 1090.
- (10) J. P. Wetherill, U.S. Pat. 1,834,814.
- (11) U.S. Pat. 1,845,784-7.
- (12) Brit. Pat. 380,110.
- (13) Brit. Pat. 360,486.
- (14) Brit. Pat. 356,283. *THE CHEMICAL AGE*, Vol. 26, p. 55.
- (15) Brit. Pat. 377,959.
- (16) Verein f. Chem. und Metallurg. Prod.; *THE CHEMICAL AGE*, Vol. 26, p. 222.
- (17) Köln-Neuessener Bergwerksverein, Brit. Pat. 365,935.
- (18) P. Seidler, U.S. Pat. 1,839,124.
- (19) Brit. Pat. 361,935. *THE CHEMICAL AGE*, Vol. 26, p. 264.
- (20) Brit. Pat. 370,793.
- (21) Brit. Pat. 357,396. *THE CHEMICAL AGE*, Vol. 26, p. 104.
- (22) Brit. Pat. 356,767. *THE CHEMICAL AGE*, Vol. 26, p. 77.
- (23) J. Soc. Chem. Ind. Japan, 1932, 35, 385. Ex. Brit. Chem. Abs. 1932, p. 1028.

(1) "Fixed Nitrogen." Chemical Catalog Co., New York, 1932, p. 8.

(2) Brit. Pat. 356,645. *THE CHEMICAL AGE*, Vol. 26, p. 55.

(3) Inst. Chem. Eng., Jan. 20, 1932. Ex. Brit. Chem. Abs., B, 1932, p. 250.

(4) Brit. Pat. 360,618.

(5) U.S. Pat. 1,809,978.

(6) R. Williams, U.S. Pat. 1,820,417.

(7) U.S. Pat. 1,830,167.

It is of interest, moreover, to note that the Interessengemeinschaft propose, for the preparation of ammonium nitrate-sulphate in a form suitable for storage, the admixture of urea and of a non-deliquescent salt capable of combining with the water of crystallisation, such as salts of magnesium or of aluminium.

Nitric Acid and Nitrates

For the manufacture of nitric acid by the oxidation of ammonia, several modified forms of burner have been suggested. C. B. Clark (24) describes an oxidation element consisting of a platinum gauze cylinder, the length of which is approximately twice its diameter. This is surrounded by a heat radiating wall for the maintenance of the reaction temperature; and the mixture of ammonia and air is led into the cylinder. Another burner employing platinum gauze is described by J. Y. Yee (25); and the Du Pont de Nemours Co. have recommended poly-layer gauzes consisting of more than four layers (26). The use of more than one layer of gauze has been tested in previous work and has been found to lead to stability of reaction; but, in general, the number of successive gauzes employed was not more than three. With non-platinum catalysts, a new note has been struck by a suggestion of the use of tin oxide (27).

Passing to the conversion of the nitrous gases, resulting from the oxidation of ammonia, to nitric acid, H. Frischer (28) has described a process of the class involving the condensation of the reaction water before the secondary oxidation of the nitric oxide to water-soluble products has taken place to an appreciable extent, the nitrogen oxides being then converted to concentrated nitric acid by the enrichment method without the addition of extraneous water. In another specification dealing with the condensation of nitrous oxides and their conversion to concentrated acid by enrichment (29), these are absorbed in 90 per cent. of nitric acid, which is afterwards diluted to 80 per cent. strength and treated with oxygen under pressure.

The product is, finally, fractionally distilled. The production of concentrated nitric acid by enrichment methods has also been dealt with in considerable detail by G. Fauser (30). The nitrogen oxides, after condensation of reaction water and secondary oxidation, are cooled to -10° C. under a pressure of 10 atmospheres. The liquid nitrogen peroxide thus obtained is treated with dilute nitric acid and oxygen under sufficient pressure to maintain liquefaction. It is stated that approximately twelve hours are required for a satisfactory degree of reaction if the system is kept at 15° . At 70° , a reaction time of about four hours is necessary. The excess of nitrogen peroxide is removed in a rectifying tower, filled with Raschig rings, at atmospheric pressure. The cost of the process is stated to be only a little more than one-half that of concentration by sulphuric acid. If required, the time of reaction between the nitrogen peroxide and the dilute nitric acid, in the presence of oxygen, may be reduced by introducing the last named gas through a finely porous sieve plate. Thus, at 80° and 15 atmospheres, thirty minutes treatment was sufficient for the production of a 95 per cent. nitric acid.

Several improvements in the sulphuric acid concentration of nitric acid have been published during the year. The Du Pont de Nemours Co. (31) describe procedure according to which a mixture of sulphuric acid with dilute nitric acid is allowed to flow downwards through a fractionating tower,

which is heated by nitric acid vapour passing upwards through the tower and derived from the distillation of the effluent flowing from the bottom. Note may also be made of the study of the velocity of adsorption of nitrous vapours by sulphuric acid which has been carried out by L. Szegö and A. Malagutti (32). The rate of solution depends mainly on diffusion effects in the gas phase and, to a lesser degree, on liquid diffusion. This explains Hempel's observation that the velocity is independent of whether the gas phase consists of nitrogen peroxide or of trioxide.

The reaction between nitrogen peroxide and potassium chloride, by which potassium nitrate and nitrosyl chloride are produced, has been investigated by C. W. Whittaker, F. O. Lundstrom and A. R. Merz (33). The presence of water is necessary; and a tower initially filled with potassium chloride may be converted into potassium nitrate having a purity of over 90 per cent. The conversion of potassium chloride to nitrate by the action of nitric acid or of nitrous gases is also the subject of a patent specification of the Kali-Forschungs-Anstalt, O. Haselitz and B. Uebler (34).

Other Nitrogen Compounds

Several patents which have appeared during the past year deal with the manufacture of alkali or alkaline earth cyanides or cyanamides. Thus, H. Wittek (35) states that the reaction between the oxide of an alkaline earth, ammonia and carbon dioxide at a red heat is facilitated by adding halides or other compounds of the alkali metals. This action is somewhat similar to that of calcium fluoride or chloride in the formation of calcium cyanamide from the carbide and nitrogen; moreover, sodium chloride may also be added to a mixture of finely divided coal and sodium bicarbonate to give a very reactive briquette for the Bucher cyanide synthesis (36). The mass is previously carbonised at 400° to 450° C.

Finally, a catalytic reaction leading to hydrocyanic acid forms the subject of a specification of the Interessengemeinschaft (37). Gases containing ammonia, oxygen and a hydrocarbon are passed at a high temperature over contact bodies such as platinum or oxides of the rare earths. The product is cooled and the hydrocyanic acid is absorbed by alkalies. As a special catalyst, platinum containing ten per cent. of rhodium is recommended.

From the above summary, it will be seen that, while the number of papers and patents in this field which have appeared during the past year may possibly be somewhat less than in previous years, the ground covered by these is more or less normal. No outstanding new trend of work has appeared during the year; indeed, nitrogen fixation and its attendant processes have now become definitely standardised; and the absence of a large number of proposed improvements is a symptom of the technical stability of the methods now adopted.

Oil and Colour Chemists Association's Satisfactory Year

THE Oil and Colour Chemists' Association has to record another satisfactory year, as has already been recorded in the report of the council presented at the last annual general meeting. Since the date of that report this progress has continued. Mr. J. A. Frome Wilkinson was elected president in succession to Mr. Noël Heaton, who retired at the end of last session. Great interest continues to be taken in the papers read before the Association and communicated to the Journal, this being evidenced by the increasing number of members and visitors who attend the meetings.

The opening meeting was held at the Palace Hotel, Broomsbury Street, London, preceded by an informal dinner. The annual dinner was again held at the Connaught Rooms, and was as usual followed by a dance. Many papers were presented at the meetings of the Manchester Section. Mr. Campbell has been succeeded in the chair by Mr. A. Hancock.

Owing to the pressure of other work, Mr. A. A. Drummond resigned his hon. editorship, and the council recorded its appreciation of his work. Mr. G. Coping has succeeded Mr. Drummond, with Mr. G. C. Atfield as editor of the bibliography. The paints, pigments, varnishes and resins section of the annual reports on the Progress of Applied Chemistry (1931) was again produced by members of the Association under the editorship of Mr. Drummond.

- (24) U.S. Pat. 1,828,318.
- (25) U.S. Pat. 1,821,956.
- (26) Brit. Pat. 357,591. *THE CHEMICAL AGE*, Vol. 26, p. 146.
- (27) J. Appl. Chem. Russia, 1931, 4, 183. Ex Brit. Chem. Abs., 1932, p. 381.
- (28) Brit. Pat. 363,436.
- (29) E. Collett, Brit. Pat. 362,908.
- (30) Chem. and Met. Eng., 1932, 30, 430; Giorn. Chim. Ind. Appl., 1932, 14, 348.
- (31) Brit. Pat. 361,161. See also, Hechenbleikner, U.S. Pat. 1,818,711.
- (32) Giorn. Chim. Ind. Appl., 1932, 14, 12. Ex Brit. Chem. Abs., 1932, p. 304.
- (33) J. Ind. and Eng. Chem., 1932, 23, 1410.
- (34) Brit. Pat. 362,162. *THE CHEMICAL AGE*, Vol. 26, p. 264.
- (35) Brit. Pat. 364,225. *THE CHEMICAL AGE*, Vol. 26, p. 384.
- (36) A. Mentzel, Brit. Pat. 361,814.
- (37) Brit. Pat. 351,004.

The Department of Scientific and Industrial Research

Chemical Research in 1932

This article reviews investigations of chemical interest which have been in progress at the various stations of the Department of Scientific and Industrial Research during the past year. The research associations formed under the scheme of the Department for promoting research in industry also include chemical investigations of considerable importance in their programmes.

PREVIOUS research on canning carried out at the Low Temperature Research Station has shown that the corrosion of tin by citric acid in the presence of a limited supply of air was markedly increased over the pH range 2.4 to 5.5 when 0.005 per cent. of iron was present in solution. Further tests have been made to ascertain the effect of varying small amounts of iron as citrate in solution on the corrosion of this metal by a 0.5 per cent. solution of citric acid. The results of similar experiments with copper indicated that the effect of copper as an accelerator of corrosion is much less than that of iron.

Earlier work at the station has shown that certain sugars, particularly those derived from beet, contain an inhibitor of the corrosion of steel. Experiments with greenages, cherries and loganberries carried out at Chipping Campden with sugars tested at the station have demonstrated that the use of such sugars is of value in delaying the formation of hydrogen swells and perforations for several months, even at a storage temperature of 35°C . Confirmatory tests with these and other fruits are necessary but there is definite evidence that sugars with pronounced inhibiting properties will offer an appreciable advantage in fruit canning.

Corrosion Problems

A simple method for following the dissolution of metals in salt solutions based on determinations of the volumes of oxygen absorbed and of hydrogen evolved by analysis of samples of gas periodically removed from above the corroding liquid has been developed at the Chemical Research Laboratory. Application of the method to the dissolution of magnesium in 0.0001N and 0.001N solution of sodium chloride has confirmed the absence of appreciable oxygen absorption in these cases. Work has also been in progress on the corrosion of immersed iron and steel under oxygen pressures up to 25 atmospheres. The results have shown that passivity does not occur; that hydrogen is evolved at pressures up to at least three atmospheres; and that the corrosion-rate/pressure curve is not linear but contains two important inflexions. The protection of magnesium alloys against air and sea-water spray by selenium films has also been examined systematically and the results indicate the superiority of these films over all other known coatings.

Value of Polished Nickel Coating

The brilliant lustre and high degree of whiteness that characterise the surface of polished nickel constitute important factors in the wide application of this metal as a protective and decorative coating. It is a disadvantage that under many conditions of exposure it suffers from "fogging," a condition in which the initially high reflectivity is rapidly obscured by a dull creamy-white film on the polished surface of the metal. The effect is attributed mainly to the catalytic oxidation of small amounts of atmospheric sulphur dioxide at the metal surface when a critical relative humidity of about 70 per cent. is exceeded. Investigations at the Chemical Research Laboratory have shown that the process is affected by light, film formation being approximately halved when light is completely excluded. In the early stages the film contains nickel sulphate with free sulphuric acid but in the later stages it consists of basic nickel sulphate which cannot be dislodged without abrasion of the metal. It has also been shown that the formation of the primary film may be largely suppressed by pre-exposure to an atmosphere containing traces of hydrogen sulphide, which appears to act as an anti-catalyst. Fogging may also be inhibited by alloying the nickel with chromium or by covering the surface with a film of lanoline.

Research on Synthetic Resins

During the past year experiments at the Chemical Research Laboratory have shown that mono-, di- and tri-ethylamines are efficacious catalysts in the formation of phenol-formaldehyde resins. Such resins have been prepared by a simplified process from low temperature tars and from vertical retort

tars. The resinous products from low temperature tars have been found to possess good insulating properties as determined by high breakdown voltages, low power loss factors and high surface resistivities and favourable conditions have been determined for the manufacture of cheap products. The influence of the catalyst on breakdown voltages has been examined by effecting standard phenol-formaldehyde condensations in the presence of various condensing agents, and testing the resulting resins on tissue paper. Trimethylamine, dimethylamine, methylamine, pyridine and ethylenediamine were approximately equivalent, but diethylamine and ethylamine were not so good, while triethanolamine was definitely deleterious. Washing the resins with benzene raised all breakdown voltages to about 2,000 to 2,400 volts/mil. and indicated the importance of similar washings in the production of tar phenolic resins.

Comparative experiments have shown that vertical and horizontal tars are less amenable than similar low temperature tars to the formation of bakelites, mainly because their resins are more soluble in neutral oils and are accordingly more difficult to isolate. Acetone-formaldehyde condensations have given as a noteworthy result a volatile colourless liquid which passes into a gel stage when irradiated with a quartz mercury vapour lamp. The work has proceeded towards production of hard colourless resin and, more recently, an elastic resin has been prepared which retains its resilience for some months.

High Pressure Chemistry

A general investigation of high-pressure synthesis initiated in the Chemical Research Laboratory in 1926 has been continued. Earlier experiments have shown that in catalytic reactions between carbon monoxide and hydrogen under high pressures, metallic oxide catalysts prepared by precipitation with aqueous caustic potash led to a decreased yield of methanol and increased production of higher alcohols when compared with similar catalysts obtained by ignition of metallic nitrates. Investigations have accordingly been made to determine the influence of varying amounts of different alkalis on typical methanol catalysts. A basic catalyst containing a mixture of chromium and manganese oxides in molecular proportions was impregnated with various amounts of the hydroxides of the five alkali metals, and these alkali catalysts were employed under standard conditions in a high pressure convertor. The rubidium-impregnated catalyst containing 9.8 per cent. of rubidium proved to be the best catalyst of the series for securing a high yield of higher alcohols. A new heptanol, namely, 2:4 dimethylpentanol, was included among the alcohol products. Research on the synthesis of ethyl alcohol has led to a marked increase in the yield of this alcohol such that it may now be made the major constituent of the liquid product. Methane, however, is still simultaneously produced in considerable amount and efforts are being made to suppress its formation. High-pressure technique has been applied to the amination of phenol and its homologues with ammonium chloride.

Constitution of Tars

An investigation of the chemical constitution of tars and their possible use as a source of fine chemicals has been continued at the Chemical Research Laboratory. This work, which has led to the development of a technique suitable for the examination of these products and has resulted in the identification and characterisation of a large number of constituents, has now been extended to include the influence of variations in temperature, type of coal and type of carbonisation process on the yields of the more important constituents of the tar.

In connection with hydrogenation of low temperature tars experiments have been made at the laboratory in order to show the result of hydrogenating low temperature tars at comparatively low temperatures and the effects of hydrogen on selected tar constituents under conditions favourable for the

production of fuel oil. In the first series of experiments conversion of tar into volatile oil was not considerable but fundamental changes had been made in certain tar constituents particularly when molybdcic acid-sulphur was employed as the catalyst. The content of resinoids in the original tar was greatly reduced and in particular the percentage of resinols dropped from 7.7 to 1.1, whereas phenolate-soluble material, consisting chiefly of resinenes and representing 6.1 per cent. of the topped tar, was eliminated by hydrogenation. Neutral oil accounted for 67 per cent. of the hydrogenated product, showing an increase of 14 per cent. over the neutral oil in the topped tar. In the second series of experiments, the three main resinoid constituents of low temperature tar, namely, the resinenes, resinols and resinamines, have been hydrogenated in the presence of molybdenum sulphide. When heated for two hours at 420° C. with hydrogen under 120 atmospheres, resinols yielded 66 per cent. of mobile fluorescent oil, whereas under similar conditions resinenes and resinamines furnish respectively 71 and 66 per cent. of similar oil.

At the Fuel Research Station a continuous plant has been erected for the hydrogenation of 3 to 6 gal. of low temperature tar per day. Hydrogenation of low temperature tar in this plant using impregnated charcoal containing 25 per cent. ammonium molybdate as catalyst for both liquid and vapour phases yielded 11.6 gal. of motor spirit boiling up to 200° C. and 8.6 gal. of Diesel oil from 20 gal. of low temperature tar. An extended investigation has been made at the Chemical Research Laboratory into the effectiveness of tar phenolic fractions as wetting-out agents in the mercerisation of cotton.

The Purification and Cleaning of Coal

Some 70 million tons of coal are cleaned annually in Great Britain, and it is becoming generally accepted that cleaner coal advances the interests of the coal industry along various lines. Despite the enormous quantity of coal cleaned, and the variety of the methods available for the purpose, the scientific aspects of the subject have been practically neglected, except for the work in progress at Birmingham University and by certain private concerns. The particular investigations at present in progress at the Fuel Research Station are concerned with the settling of fine coal from washery waters; the purification of fine coal; an investigation of the principles underlying the "jig" washing systems; and the development of a system for the dry cleaning of coal.

Work in progress on the carbonisation of coal is divided into two main items: (1) improvement in the design and methods of working horizontal gas retorts, and (2) the production of a solid free-burning smokeless fuel for domestic purposes.

The new programme provides for the erection of a plant to hydrogenate some 2 tons of tar a day with a view to the production of motor spirit and Diesel oils, and possibly lubricating bases. Experiments are in hand in smaller plant for the study of suitable catalysts. A few experiments have been carried out in which the effect of catalysts on the partial hydrogenation of coal has been studied. Catalysts have been found greatly to accelerate the early stages of hydrogenation and it is proposed to extend this work. The complete hydrogenation of coal in the presence of catalysts has also been studied in 2 litre gas heated convertors.

Water Pollution

The study of the colloids in sewage and the conditions which affect their quantity and nature has been continued for the Water Pollution Research Board at University College, London. An improved method for the determination of organic carbon has been devised and the micro-Kjeldahl method for the determination of total nitrogen in sewage liquors has been successfully applied. A large number of samples of a particular type of domestic sewage has been examined by simple sedimentation, by centrifuging at different speeds and for various periods of time, and by filtration, mainly through ultra-filters consisting of membranes with extremely fine pores. It has been concluded that the major portion of the dispersed matter in the samples examined is relatively coarse and can be separated by simple sedimentation or centrifuging. Only a small proportion is in the form of dispersed particles so fine as to be of the order of size of true colloidal sols.

Investigation of the base-exchange process of water softening has been continued at the Chemical Research Laboratory. The use of sea water for the regeneration of base-exchange materials has been examined and further comparative studies have been made of the behaviour of these materials under varying conditions of regeneration. For example, it has been shown that the base exchange values of one type of material rise progressively as the time of contact with a 5 per cent. solution of salt is increased from 2 to 90 minutes.

Building Materials

Many problems of chemical interest are in progress at the Building Research Station but it is possible here to refer only to one or two of these. During the last four years useful data have been accumulated in the study of problems connected with the florescence of bricks and other clay products. This study has involved an examination of the chemical properties of the raw clay and the changes brought about in it by the firing process, and also of those physical properties which are of importance in determining the constitutional resistance of a brick to forces of disintegration. The results have shown that the most important factors are the nature and amount of the soluble salt content, and the "texture" of the brick. Texture includes all those properties of the brick which go to determine the direction and rate of movement of water and the position of crystallisation of soluble salts under the conditions imposed by association with other materials in a building.

Many properties of certain building materials can only be explained by a knowledge of the behaviour of materials which possess a gel structure. To obtain the necessary fundamental data, investigation is being made of the relevant properties of silica gel.

The Storage of Meat

Work at the Low Temperature Research Station has shown that an unpleasant tainted flavour and a high free acidity in the fat of chilled meat are directly due to the activity of micro-organisms. For some time an economical means of checking the growth of moulds has been sought. The maintenance of a low humidity in store would have this effect, but apart from technical difficulties of obtaining it in a hold or store closely packed with meat a low humidity results in loss in value of the carcass owing to loss in weight and withering of the surface. Hitherto the use of carbon dioxide has been left out of consideration for practical purposes, although it has long been known that moulds do not grow in high concentrations of the order of 50 per cent. or more of this gas. It has now been found that the inhibiting effect of carbon dioxide on the growth of moulds and bacteria on meat and connective tissue stored at or near freezing point is appreciable, even at so low a concentration as 4 per cent. With 20 per cent. concentration of carbon dioxide, the inhibition is so marked that, if judged by this criterion alone, the life of meat is at least doubled. The presence of this concentration of carbon dioxide also markedly reduces the production of free acid in the fat of beef without increasing the amount of oxidation.

Viscosity of Cellulose

In a number of industries the extent of chemical degradation of cellulose is closely related to other properties of the material, themselves of primary importance, either to the proper working of the industrial process or to the performance of the industrial product. The viscosity of a cellulose solution is a sensitive index of the extent of chemical degradation of the dissolved cellulose. It therefore provides a very valuable means of process control in bleaching and other chemical finishing operations applied to cellulose textiles and to cellulose papers and pulps for other industries such as paper making, and in the manufacture of rayons, explosives, celluloids and lacquers. It also affords a means of specifying the quality of the raw material in such of these as start from a bleached or chemically processed cellulose. Measurements of the flow properties of cellulose solutions are associated with peculiar difficulties not encountered in ordinary viscosity measurements. These difficulties are largely responsible for the lack of uniformity in the method of making the measurements and of expressing the results. In response to the expressed desire of the industry the Fabrics Research Committee of the Department has formulated considered recommendations for a standard method and form of expression for industrial purposes.

Ottawa and After from the Chemical Point of View

By Dr. E. F. ARMSTRONG

THE growth of the chemical industry has been one of the outstanding developments in British industry since the war. There is every sign of its continuance in a still more active state in the new period of history which competent observers believe has already begun in succession to the immediate post-war era. It is probable that future historians will date this new era from the time of the formation of the National Government and the Conference at Ottawa.

It is possible to ascribe the development of the chemical industry to many causes. Of these we have two factors especially in mind here, namely, the protection afforded to the fine chemical trade under the Safeguarding of Industries Act, and the advantages which have accrued to the industry consequent on the spirit of co-operation which has animated it. The progress of applied chemistry has been perhaps accelerated by the availability since 1918 of a number of experienced chemists who had been engaged in war work; their ranks have since been supplemented by a steady stream of men, excellently trained in the University laboratories.

The spirit of co-operation has been largely fostered by the Association of British Chemical Manufacturers. The industry collectively owes more than an ordinary measure of gratitude to those men, alas growing fewer in number, who became founder members of its Council, and who have given ungrudgingly of their time and effort for the general weal.

The Home Market Secured

It is now a matter of industrial history that just prior to the war the chemical industry was losing ground as a whole, although fighting valiantly, and that the Safeguarding of Industries Act, with its 33½ per cent. protective duties for a long list of chemical substances, just came in time to save the fine chemical section of the industry, which has been enabled under its shelter to develop at a steadily increasing rate, until it has begun to assume a position of definite importance in the export markets, as well as supplying home needs. Under the new tariffs imposed by the Import Duties Act passed by the National Government, acting on the advice of the Tariff Advisory Committee, certain other chemicals have received a greater or less measure of protection. This has only been granted after a thorough and searching inquiry into the facts of the case. In the main, therefore, the home market is secured to the industry, so long as it remains efficient, and when normal trade returns this opportunity should bring prosperity to the firms concerned in it.

Until the Ottawa Conference the position in the Dominion markets was far less satisfactory, for although in the main an English preference had been granted, it was not for a variety of reasons sufficient for most of our industries to be able to gain an adequate share of the trade.

It is desirable, before discussing the more purely chemical side of Empire trade, to consider the subject in its broader aspects. It is more than ever necessary for chemists and chemical manufacturers to have knowledge of these general questions and to take an active part in influencing public, political and, ultimately, ministerial thought in the right direction for their solution. It is only in this way that we can ensure such action as will help trade and industry, and with them unemployment. In future, Government action must have relation to economic necessity and it can no longer be allowed to be based on the political exigencies of the moment.

The Empire as an Economic Unit

The United Kingdom in itself is far too small an economic unit to stand alone, the more so as the proportions of industry and agriculture in its make-up are not balanced. With the Dominions and the Colonies included the position becomes quite different; there is a balance between manufacturing industry and agriculture, the necessary raw materials are plentiful, and a unit is obtained equal in size and population to at least one-quarter of the globe. The units of the Empire are widely scattered, but distance has become so largely eliminated—wireless, telephones, speedy posts by ship and aeroplane make personal contact over great distances only a matter of expense—that there are few limitations in the way of doing business such as existed fifty or even twenty years

ago. It seems an obvious idea to render the Empire an economic unit, to use Empire raw material in British factories from which to make manufactured goods for every subject of the King-Emperor to buy and use. It should have been developed long ago, before the larger Dominions had begun to build up industries of their own or had let their importing houses and shopkeepers be seduced by the sellers of foreign goods, but the opportunity has been missed more than once. The world crisis is so devastating that it has swept away the little man with mean thoughts, whilst the people wait for leaders with imagination; wait impatiently while experts differ. Something has to be done at once. This was the feeling which brought about the, at first, astounding result of the general election in 1931.

Bigger Ideals

It is common knowledge that the previous Empire Conference in London had failed; perhaps the gravity of the issues had not then been appreciated. Much therefore depended at Ottawa on the spirit with which the weighty problem was approached, whether sectional interests were to dominate over the realisation of the dream of a united Empire, within which men, and women too, would be free under the flag to work and to play, to manufacture and to trade, without restriction, with the common weal as their limitation and the common cause at their heart.

Big ideals, perhaps, for a conference in connection with the words bargaining, even sordid bargaining, have been used by would-be detractors, but ideals which were necessary if the high purpose was to be obtained. Whilst everyone realises the absolute need for co-operation, for a larger unit, few are prepared for the individual sacrifices it entails.

Until the abandonment of the policy of unrestricted Free Trade, Great Britain had nothing to offer to her Dominions. Under the provisions of the Import Duties Act duties were levied on a large number of products in which the Dominions, India and the Colonial Empire were concerned. The former were exempted until November 15, 1932, from the operation of these duties; the non-self-governing colonies were exempted unconditionally. The conference therefore had the task of settling the policy which was in future to govern the tariff relations between the Mother Country and the Dominions.

Free and Frank Discussion

The United Kingdom delegation to the Conference consisted of the official party of politicians and civil servants, together with three industrial advisers and a large unofficial delegation of industrial representatives. These were organised under the auspices of the Federation of British Industries as a committee, of which Mr. W. J. U. Woolcock acted as chairman. This was almost continually in session throughout the several weeks of the Conference. It must have been the first time that so many leaders in almost every branch of industry were brought into intimate personal contact whilst pursuing a common cause, and the consequence of the relationships so established is perhaps of as great potential value as any other outcome of the Conference. Matters of great importance were discussed freely and *in camera* by this committee, over which Mr. Woolcock presided with great wisdom and skill. The success in holding together the industrial deputation at the Conference has undoubtedly strengthened the position and influence of the Federation of British industries in the Dominions and added new interest and potentialities to the work of its overseas committee, which is to be continued. A considerable amount of secrecy was necessary at the Conference, and the loyal way in which the obligations were observed deserves a tribute to all concerned.

Canadian Conditions

Since the Conference took place at Ottawa it was natural that Canadian affairs should loom large in its operations, and although important contacts were made with industrial representatives of the other Dominions, it was primarily with the Canadian manufacturers that views were exchanged. The Canadian industries, which are considerable in the aggregate, are organised by a Canadian Manufacturers' Association,

which for the purpose of the Conference had established a tariff section under the control of Mr. Bristol. There is no separate chemical association, the individual chemical firms being members of the C.M.A. There is a growing chemical industry in Canada, which is largely non-competitive among itself, though subject to great competition from the United States and from Europe. The largest producers are Canadian Industries, Ltd., and next comes Shawinigan, the two firms between them representing over 70 per cent. of the total output in Canada. The Canadian makers exist either to supply the Dominion demand for their products or are based on cheap electricity from water power, as, for example, Shawinigan and the Electric Reduction Co. Two firms, Mallinchrodt and Merck, are developing the manufacture of fine chemicals.

Prior to the Conference there was in existence a tariff on a large number of chemicals which were not made in Canada, imposed supposedly for revenue purposes, as well as a definite protective tariff for substances made in Canada. Under the general scheme underlying the Conference it was aimed to open the Canadian markets without let or hindrance to the products of the United Kingdom, except in so far as the developing Canadian industries required some measure of protection, such concessions to be in exchange for concessions in regard to wheat, meat and other materials on the part of the United Kingdom. The products of the chemical industry formed a group to which this scheme could be applied without any great difficulties arising, and it is therefore not surprising that the tariff policy in regard to them has been largely changed. The Association of British Chemical Manufacturers, which, as is well known, was represented at Ottawa by its chairman, Dr. E. F. Armstrong, and its general manager, Captain J. Davidson Pratt, had prepared a detailed schedule incorporating its opinions well before the Conference for the use of the Board of Trade.

Group Selling Scheme

The actual changes in chemical tariffs in Canada have already been given in full in *THE CHEMICAL AGE* and elsewhere. Many substances are now admitted free from the United Kingdom, with a substantial preference over the foreigner, the exceptions being a limited number of chemicals made in Canada.

Most English chemical houses are represented in the Canadian chemical market, either directly or through agents, and of course the same applies to the competitive European and United States firms. There is no doubt that, considering the total population of Canada, the competition to satisfy its requirements is perhaps keener than in any other market. A study of the conditions in Canada has caused the writer to make certain suggestions as to the manner in which English houses might co-operate. These are in my address as chairman of the Association of British Chemical Manufacturers, and have already been set out in *THE CHEMICAL AGE* with some editorial comment, so that it is unnecessary to do more than repeat the conviction that the trade must be diligently sought, for it will not come of its own volition, with the further aphorism that there is no time like the present. The genius we have shown in the past for spontaneous organisation must give place to pre-arranged planning. We need unity of purpose, with scope for diversity of expression.

Other Imperial Concessions

Similar concessions have been given by Australia, though here the change has been made by way of a formula giving a growing United Kingdom preference according to the total duty on the product. South Africa at present lags behind in its willingness to encourage our home products, but a start has been made in the right direction. New Zealand has already given such substantial preference to British chemicals that there is little more to be done.

The relation of India to the Conference is of considerable importance, particularly in view of the potentialities of that Empire for the chemical industry. The Indian tariff is mainly a revenue one, in which there was little scope for any sacrifice until Great Britain was ready to give India definite fiscal benefits. This was impossible until the passing of the Import Duties Act. The bulk of the British exports to India are in competition with Indian manufactured articles, so that concessions could only be extended to commodities representing a little over one-fifth of the total imports in value. Whilst

these include some chemical products, they do not include dyes, which carry at present a relatively small duty. India is to-day on the eve of setting up a new constitution, and it is hoped and anticipated that the Government will shape its policy so as to encourage Empire manufactures. India is one of the most important markets for dyestuffs, so that every effort must be made in the future to secure a preference for the United Kingdom maker. Such preference must be adequate, otherwise it fails in its object, since it involves an unnecessary sacrifice of revenue without benefiting the country to which it is accorded.

American Opinion

It is of interest to quote American opinion, expressed in "Chemical Markets," on the results of the Conference. It is considered that chemicals will bear the brunt of the attack on American imports into Canada, which incidentally since 1928 has been the best single customer for chemicals of the U.S.A. It is thought likely that American producers may establish branch plants in Canada. It has been stated also that Great Britain gained considerably more than the objective sought at first.

Expert opinion in America is said to hold the view that the chemical industry will be the first to recover, whenever this much desired event takes place, and that in any case the next decade will continue to see a growth in the use of chemicals of all kinds and the employment of chemical technique. Very much the same view has been expressed by Mr. Bennett, the Canadian Premier, though in more resounding phrases. He pictures industries turning to research, science becoming applied rather than academic, and the power of the chemical factor in modern life continually increasing; the Empire and Canada sharing in the growth, and gaining by the development towards self-sufficiency in a chemical sense.

In discussing events under the heading "After Ottawa," we do so at a moment when it becomes more evident each day how acute the world crisis is, a fact which can hardly arouse surprise, seeing that the attitude taken by the individual nations cannot but help to aggravate the position. Week by week new difficulties are placed in the way of the former channels of trade, and it is rapidly becoming impossible for any nation to have an export trade.

Britain's Great Hope

Without enumerating the causes, including the payment of war debts, which are aggravating the situation, it is at least clear that for a country like Britain, which has necessarily left the gold standard, it is becoming an impossible strain to acquire dollars or francs in sufficient quantity for us to trade with the United States or France, and that our only hope is to create a section of the world sufficiently large in size and population which will be on a sterling basis, and which will contain the necessary raw materials and manufacturing capacity to enable its population to satisfy all its demands. The British Empire constitutes such a unit, and associated with the Scandinavian countries and some others in Europe, it should be possible to create a sterling group having no necessity to make purchases from the countries on the now arbitrary gold standard. Such a solution of the problem is fast becoming the only one possible. The importance of Ottawa when it is seen from this angle becomes obvious—given freedom of trade within the Empire, with the absolute minimum of protective tariffs and the abolition of the tariff on Empire goods as a means of collecting revenue, as well as the abandoning of the vexatious customs administration, there will be no obstacle in the way of each and every part of the Empire building up a trade with any other part of it.

To-day the chemical industry is strong in itself, both technically and financially, efficient and energetic in its organisation; the spirit of co-operation is more than ever alive, and new tariffs at home, in addition to the preferences in the Dominions resulting from Ottawa, assure it the necessary protection against countries with a lower standard of living and labour costs. In particular, if our view is correct, the markets of the Empire, with a potential trade of upwards of £20,000,000, are within its orbit and with the necessary display of resolute energy the possibilities of extension are very numerous. Surely it is as true to-day as when the Elizabethan poets first said it, that England since it was England never had more honourable minds, more adventurous hearts, more valorous hands or more excellent wits than of late.

The British Association of Chemists

Expanding Activities and Membership

DESPITE the depression of industry the British Association of Chemists has completed another highly successful year. The net increase in membership for the past year has been 99. The number of chemists applying for membership continues to be maintained and 54 new members were elected in November. This satisfactory position is due to the increased activities of the Association. The unemployment benefit fund, the appointments bureau, and the legal aid department have had a record year of activity. This is due to the fact that in times of difficulty both industry and the individual professional chemist are in great need of the assistance which such an association is capable of giving them. In the first place the unemployment benefit fund has now paid out since its inception more than £8,000; and £1,500 has been disbursed to members during the past year. An increasing number of chemists are realising that since economic security can hardly be said to be certain for any individual, it is desirable to ensure against the probability of unemployment.

The Appointments Bureau

On the other hand, the percentage of unemployment within the Association remains low. The appointments bureau has earned the just reputation of being able to supply a suitable candidate for any chemical appointment which is offered. It is safe to add that if an employer cannot suitably fill a position after application to the bureau, he will find it difficult or impossible to do so by other means. For the welfare of industry as much as for that of the community, methods have to be found to increase the number of persons employed and at the same time decrease the costs of production. The co-operation of directors of industry with chemists and other scientific men, and with the organisations which represent them, is the only method of achieving this. The bureau has filled a large number of important appointments during the past year. It has been the Association's experience that the suitable applicant for a post is always able to command an adequate, and in many cases, a substantial salary.

Work of the Legal Aid Department

The legal aid department has had the most active year since its inception. A notable case contested by members was Green also Marsden v. British Celanese. The company claimed the right to terminate the agreements of the plaintiffs under a clause which provided, in their opinion, for a notice of termination before a certain date. Failing such notice the agreement was to continue for a further stipulated period. In the view of the plaintiffs notice had not been given in accordance with the terms of the agreement, and they accordingly brought an action against the company for breach of it. Judgment was given for the plaintiffs in the sums respectively of £1,450 and £670 and costs. An appeal by the company was dismissed. In a second case, Davies v. Hammond and Shackleton, there was a repudiation of contract arising out of the liquidation of the company (Submerged Combustion, Ltd.). The plaintiff was in this case awarded £557 damages and costs. These cases are quoted as being of particular interest. Others relating to termination with insufficient notice (less than three months) have also been successfully contested. A large number have also been settled out of court, due to the support given by this department.

Legal Advice on Agreements

The legal aid department has further given advice on a large number of agreements. The Association advises its members to sign no agreement in any circumstances which has not been thoroughly perused. It is not in the interests of the profession that chemists should sign agreements without fully understanding their implications, and the council notes with satisfaction that an increasing number of agreements are submitted for examination, and that cases are reported by members in accordance with its wishes where endeavours have been made to obtain signatures to service agreements without giving the signatories time or opportunity to examine them.

The activities of the sections of the Association have been well maintained during the past year. In the provinces

where joint meetings are more practicable than in London, there have been mutual invitations as between the societies and mutual efforts at co-operation in some centres for the organisation of meetings. To what extent a co-ordination of a more definite kind than this natural co-operation is possible it is not easy to determine, but the relations between the Association and kindred societies is evidence that this co-operation has been successful and has been not without value to the societies concerned and to the Association. The Council remains of the opinion that the first step towards any real policy of co-operation is the formation of a general chemical council fully representative of all societies of chemists, and it greatly regrets that this policy, first suggested by the Association eight years ago, has not received more support.

The financial position of the Association remains sound. It was again possible this year to put a sum to reserve, a small credit balance on the year's working. In regard to the unemployment benefit fund the sum placed to reserve was less than in previous years owing to the heavy call made upon it, but reserves are still being accumulated, and the fund is thus being strengthened with every year's working.

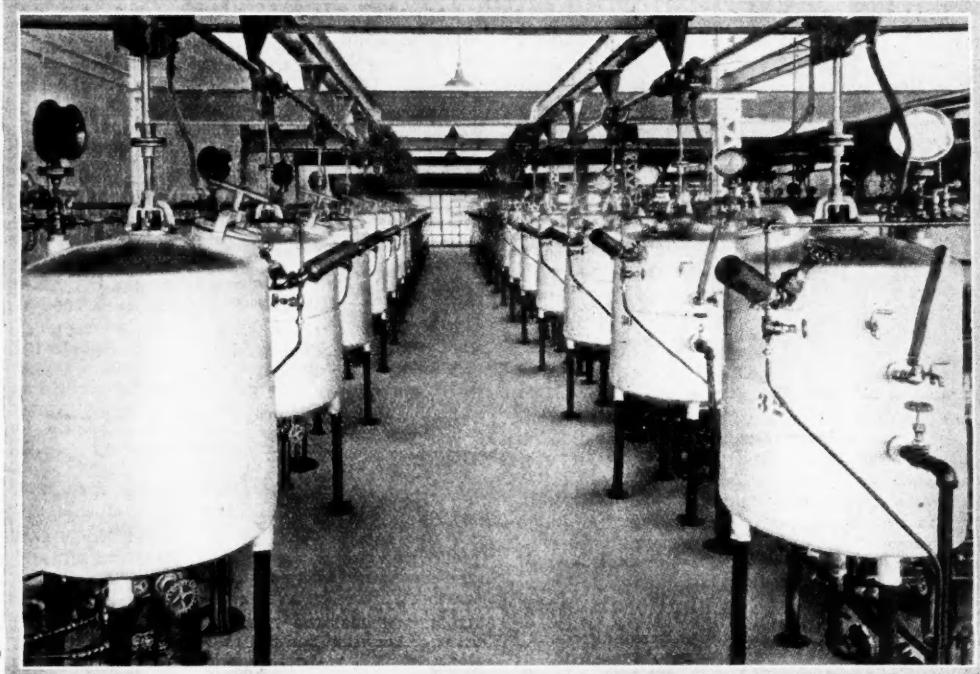
Close touch has been maintained with the Ministry of Labour regarding the employment of foreign chemists in this country. In many cases leave has been sought to employ a foreign chemist under the impression that a British chemist with suitable qualifications was not available. In many instances the appointments bureau has been able to supply a suitable applicant of British nationality, and the Association is satisfied that in no case have licences been granted other than in exceptional circumstances. The publication of the Association's activities has been maintained by means of its official organ and by reports in the technical and general Press.

British Colour Council

Some Important Developments

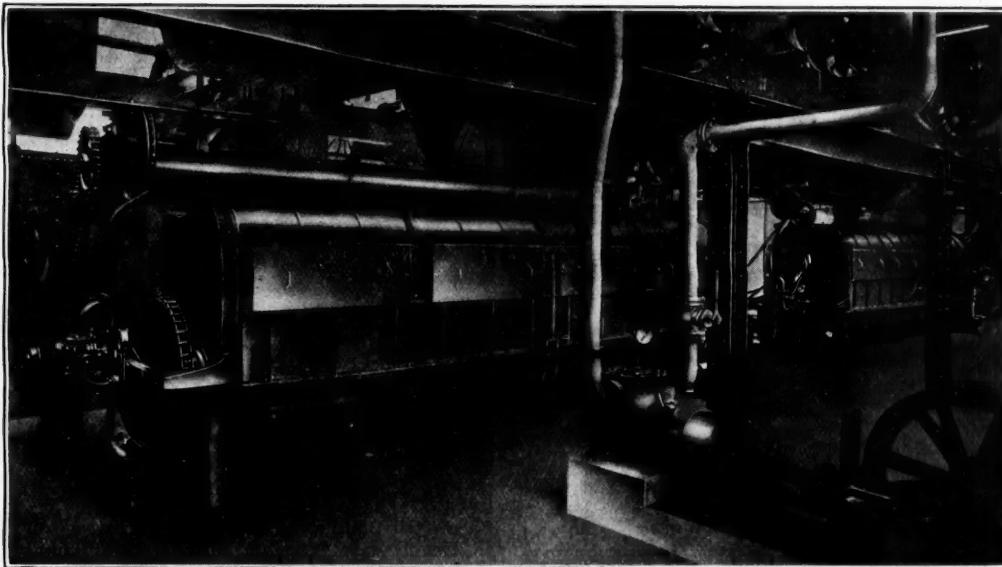
SINCE the commencement of the activities of the British Colour Council about eighteen months ago, developments have been continuous and increasingly far-reaching. Five colour cards are now issued—wool, silk, cotton, leather and hosiery—all colours being created ten months ahead of season. These colours give a safe basis upon which the various industries can commence producing. Following the issue of these cards there is a continuity of information issued to the trade journals, fashion journals and daily Press at appropriate times, and to the Dominions and foreign Press. This means that similar information to that given to dyers and other members in December of one year will be given in an interesting form to the public through the daily Press in the autumn of the following year. A "Colour News" is issued each month to keep members in touch with most recent developments. This applies to all industries connected with the textile and allied trades. Through increasing membership and consequent increasing use of colours promoted by the Council there will be a gradual reduction of the number of colours in demand for each season.

Through British Consuls and trade commissioners throughout the world the work of the British Colour Council is becoming known to the people of other countries. Information is being received from these representatives relative to the requirements of the people of those countries so that British manufacturers may have definite knowledge for the purpose of creating goods for these markets. Other important features of the Council's activities are the production of a standard card and the issuing of cards and information for the men's wear trade. The cards now issued are for seasonal colours and are issued twice a year—for spring and autumn. The standard card, however, will contain colours which are in constant demand, such as pillar box red, turquoise, saxe, bottle green, etc. It is well known that if, say, six dyers were asked to dye up to any one of these colours six different colours would in all probability be forthcoming. The card is, therefore, being produced after consultation with the leading representatives of various industries in order that the present chaotic situation may be relieved.



Manufacture of Solvents from Corn Starch

Normal butyl alcohol is now a product of extreme industrial importance. It serves as a raw material for the manufacture of *n*-butyl acetate, the most widely used of all the cellulose nitrate solvents. The greater part of the world production is made by the Commercial Solvents Corporation, whose works are in the United States. Corn starch is used as the starting point, and a fermentation process is employed. The above illustration shows a battery of 80-gallon culture tanks used for the propagation of the bacteria which are essential to this process.



Wider Utilisation of Vegetable Products

At the present time increasing quantities of vegetable oils are being utilised in the manufacture of foodstuffs, such as margarine and cooking fats. Fish waste and animal waste is also worked up for the recovery of their oil content. It is in these processes that solvent extraction is being profitably adapted. This illustration shows drying machinery installed at a modern works where vegetable oil is extracted from seeds. After passing through the extraction process the residual seed meal is dried for use in cattle feeding or as a fertiliser. In some cases the extracted meal is mixed with molasses and compressed into cakes.

Progress in Chemical Standardisation

What the British Standards Institution has Achieved

THE past year has been a period of considerable activity for the chemical division of the British Standards Institution which, it will be remembered, was formed just over a year ago with the active co-operation of the Association of British Chemical Manufacturers and other organisations in the chemical industry. The chemical division of the Institution is governed by a representative council, under the chairmanship of Dr. E. F. Armstrong. The council in the early stages laid down the following guiding principles as to how the work should proceed:—*a*) The standards which had already been published by certain chemical organisations might, after examination, be adopted and published as British Standards if the Council were satisfied that all interests concerned had been consulted in their preparation; *b*) a number of committees appointed by one or more technical and/or trade organisations which were at work preparing standards might be admitted as committees of the British Standards Institution provided that they were representative of all interests concerned; and *c*) the need for a national specification should be considered for a number of chemical materials which the trade was required to supply in quantity to a number of specifications varying only in unimportant details.

As a first step a report was prepared of the position in regard to chemical standardisation in the industry, the report including particulars of standards—both published and those in preparation—for testing methods, plants and materials.

Committees for New Specifications

After consideration of the report the divisional council appointed a limited number of committees to deal with the preparation of new specifications. At the same time arrangements were made to assume responsibility for certain items of standardisation of national interest which had previously been carried out by individual technical or trade organisations in different sections of industry. The Council also recommended that the following committees should be adopted as external technical committees of the Institution, no change being made in the secretarial arrangements, and that their standard methods should be adopted as British Standards after review and approval by the Council:—Institution of Petroleum Technologists' Committee on the standardisation of testing and nomenclature of petroleum and its products; Standardisation of Tar Products Tests Committee; International Society of Leather Trades Chemists' Committee on the standardisation of methods for the analysis of leather and tanning materials; and the Society of Dyers and Colourists' Committee on standard methods for testing the fastness of dyed and coloured materials.

Work Under Consideration

The work under consideration is shown in the following summary of sections, names of chairmen and branches of chemical industry handled:—

CREOSOTE.—Chairman, Mr. H. W. James.—Creosote for timber preservation and for fuel burning purposes.

CRESYLIC ACID AND PHENOL.—Chairman, Mr. C. Chapman.—Phenol, *n*, *m* and *p* cresols, carbolic acids, cresylic acids, high ortho acid, meta acid.

ETHYL ALCOHOL.—Chairman, Dr. E. Vargas Eyre.—Industrial and technical ethyl alcohol.

SOLVENTS.—Chairman, Dr. E. Vargas Eyre.—Acetone, acetic acid, butyl alcohol, ethyl, butyl and amyl acetate, dibutyl phthalate, methyl ethyl ketone, ethyl lactate, diethyl phthalate, methanol, dichlorethylene, trichlorethylene, hexachlorethylene, perchlorethylene, diacetone alcohol, ether, carbon tetrachloride, carbide of calcium.

CARBIDE OF CALCIUM.—Carbide of calcium.

CHEMICALS FOR PLATING.—Chairman, Mr. E. R. Evans.—Nickel ammonium sulphate, nickel sulphate, nickel anodes, potassium cyanide 95-99 per cent., potassium cyanide, grey.

ANALYTICAL REAGENTS.—Mr. W. Rintoul.—A complete series of specifications for the more commonly used analytical reagents.

SCIENTIFIC GLASSWARE.—Volumetric glassware, mould blown glassware, lamp blown glassware, thermometers, hydrometers.

STANDARD TECHNIQUE FOR DISINFECTANTS.—Chairman, Mr. A. G. Francis.

VEGETABLE OILS.—Chairman, Mr. E. R. Bolton.—Linseed, tung, cotton, coconut, palm kernel, soya, rape, sesame, castor, ground

nut, olive, maize, palm, cocoa butter, Chinese vegetable tallow, shea nut, kapok, perilla.

CHEMICAL LEAD.—Chairman, Mr. F. H. English.—Chemical lead and regulus metal.

BENZOLE, ETC.—Chairman, Mr. W. G. Adams.—Xylools, naphthas, toluols, benzols, motor benzol.

COAL AND COKE.—Chairman, Mr. Ridley Warham.—Sampling of large and run-of-mine coal, sampling and analysis of coke, sampling of coal for boiler and power station trials, agglutinating value of coal, ultimate analysis of coal, calorific value of fuels.

The development of the purely chemical work has in no way diminished the activity of the work which was already in hand in regard to chemical engineering standardisation, and a number of important specifications which have directed immediate interest to the industry have been issued during the past year, as follows:—identification of chemical pipe lines; manhole openings for chemical plants; a revision of the specification for identification colours for gas cylinders, which includes identification colours for cylinders for medical and pharmaceutical purposes.

The Biochemical Society

Nearly 800 Members

THE Biochemical Society was instituted for the purpose of facilitating intercourse between those biologists and chemists who are interested in the investigation of problems common to both, such as the chemical problems connected with agriculture, brewing, animal and vegetable physiology and pathology, etc. The Society, which reaches its majority in 1933, has now a total membership approaching 800.

The Society has held seven meetings during the year at the following places:—Lister Institute of Preventive Medicine; Department of Biochemistry, University College, London; Biochemical Laboratories, Oxford; Imperial Chemical Industries, Ltd., Agricultural Research Station, Jealott's Hill, Bracknell, Berks; National Institute for Medical Research, Hampstead; London School of Hygiene and Tropical Medicine; and the laboratories of J. Lyons and Co. All these meetings were well attended, and a total number of 55 papers were read. Inquiries as to the Society should be addressed to one or other of the Secretaries; Professor A. C. Chibnall, Imperial College of Science and Technology, South Kensington, S.W.7, in any matters except those connected with meetings of the Society, and Professor H. Raistrick, London School of Hygiene and Tropical Medicine, Keppel Street, Gower St., W.C.1, for all matters connected with meetings of the Society.

Society of Dyers and Colourists

The Year's Awards

MEETING, works visits and lectures arranged by the various sections of the Society have been held in Bradford, Huddersfield, Manchester, London, Leicester, Nottingham, Derby and Glasgow.

A bar was attached to the Gold Medal of the Worshipful Company of Dyers, previously awarded to Professor F. M. Rowe for his papers on "Constitution of some Naphthols and Fast Bases (I.G.) used for the production of Insoluble Azo Colours"; "Properties of Insoluble Azo Colours on the Fibre in Relation to their Constitution, Fastness to Kier-Boiling and the Method of Testing"; "Action of Boiling Caustic Soda (Kier-Boiling) on Insoluble Azo Colours on the Fibre" (S. Ueno); and "Action of Boiling Caustic Soda, their Boiling on Insoluble Azo Colours on the Fibre—Part II" (F. H. Jowett). Certificates were also awarded to Professor Rowe's two collaborators, Mr. S. Ueno and Mr. F. H. Jowett.

The demand for the Society's "Colour Index" and "Supplement" is still being maintained. The work on "Standardising the Methods of Testing the Fastness of Dyed and Coloured materials" has not yet been completed, but it is hoped that a final report will be available early in 1933.

How Manufacturers Have Served the Industry in 1932

New Developments in Plant and Products

THE chemical plant manufacturers and the makers of chemical products have had a difficult year, but on the whole they have weathered the storm successfully, and are looking forward, with greater confidence than they did twelve months ago, to a brighter new year. We have invited manufacturers to tell us something of what has been accomplished in the past year, and their response is shown in this and following pages.

THE most outstanding advance which has been made in the British Drug Houses, Ltd., technical laboratories during 1932, is the production of pure crystalline vitamin D on an industrial scale. Adopting the technique of workers at the National Institute for Medical Research, London, N.W.3, who first isolated vitamin D in a pure crystalline form a plant was installed early in the present year for producing it as a commercial proposition. The result is a large-scale production of pure crystals of vitamin D exactly similar to those produced in the laboratory of the Institute of Medical Research. For a long time past the difficulties surrounding biological assays (particularly of vitamin A) have been recognised; for instance, many animals are required in order to carry out one single test satisfactorily, and even when they are selected with the greatest care, considerable variations in response to the same dose of vitamin occur. It is hoped that the systematic investigations which are now being carried out in connection with the international unit for vitamin A will make it possible to produce concordant results within a narrower margin of error, but up to the present it has not been found possible to make use of the International Unit for expressing vitamin A activities. In the meantime, the only satisfactory method of standardising vitamin A preparations is by means of the well-known chemico-physical tests such as the Carr-Price colour test and the determination of the intensity of the absorption in the ultra-violet region of the spectrum. The measurement of the colour is carried out in a Lovibond Tintometer. It is realised that the latter test as a means of determining directly the vitamin A content of any given substance has its shortcomings, but by a process of purification of the vitamin A concentrate used in the British Drug Houses preparations containing this vitamin, it has been found possible to eliminate the bulk of the foreign substances which mask the blue colour. This concentrate is employed for making the British Drug Houses vitamin A preparations which are used in medicine.

Broom and Wade, Ltd.

DURING 1932 Broom and Wade, Ltd., have developed their standard range of rotary air compressors and exhausters, and are now supplying them in increasing numbers to the chemical industry. These machines are extensively used for agitation, humidification, impregnation, gas compression

they are extensively used, both compressors and exhausters, is for the transference of liquids from one vessel to another, such as from storage to tank lorry or railway tank truck, and from there to other tanks, the whole process enabling the most dangerous acids to be transferred with a minimum of risk and wastage. Standard sizes are available, having displacement of from 6 to 2,300 cu. ft. per minute and for pressures up to 40 lb. per sq. in. as single stage compressors, and they can, of course, be compounded for higher pressures if desired. Arranged as exhausters they are suitable for up to 99 per cent. of perfect vacuum depending on the size and whether single stage or compound. "Broomwade" standard reciprocating type air compressors and vacuum pumps have also been improved and additional sizes added to their already comprehensive range and the single acting type are now available in sizes from 3 to 1,200 cu. ft. per minute capacity and double acting type in either single or multi-stage up to 5,000 cu. ft. per minute capacity.

One of the single acting type as recently supplied to Unilever, Ltd., has a delivered capacity of 1,000 cu. ft. of free air per minute to 80 lb. per sq. in. pressure, it was arranged for short centre vee rope drive from a 175 b.p.h. slipping motor.

The British Hanovia Quartz Lamp Co., Ltd.

THE British Hanovia Quartz Lamp Co., Ltd., introduced a new fluorescence valve this year for its Hanovia ultra-violet apparatus, which has done much to extend the use of this



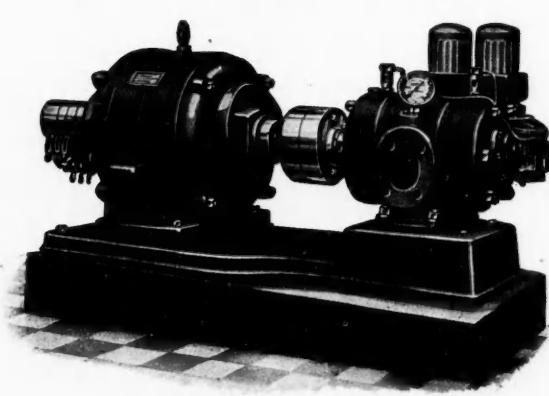
The British Hanovia Quartz Lamp.

quick and handy differentiation-analysis test in industrial chemistry. Known as the Utility model, the new outfit is portable, handy for bench work and supplied at most reasonable prices. The makers have issued several technical handbooks during the year. The most recent of these, entitled "Rapid Testing by Fluorescence" is a most useful technical outline of ultra-violet radiation in analysis. It is supplied free to qualified chemists. The manufacturers claim that there is a Hanovia lamp suited to every known chemical application of ultra-violet rays:—

Photo-chemical reactions (e.g., activation of vitamins); quick durability tests (e.g., paint, soap, rubber, textiles, etc.); spectro-polarimetric tests, ultra-violet microscopy, etc. They publish a detailed catalogue of apparatus for all these various applications.

Thomas Broadbent and Sons, Ltd.

THOMAS Broadbent and Sons, Ltd., manufacture centrifugals of all types, for all purposes. Machines of this class run at high speed and are subjected to abnormal wear, tear and corrosion. Centrifugals of an inferior make are much cheaper in initial cost, but usually turn out an unprofitable investment due to maintenance and repairs. All modern improvements in metals, ball-bearings, electrical equipment and fabrication processes, are incorporated in the firm's machines. Their latest type direct electrically-driven centrifugal is designed to withstand the severe conditions which prevail in most chemical works. This machine has a massive framework, oversize ball and roller bearings, improved design of buffer bearings, large capacity basket, heavy duty motor giving extra rapid and smooth acceleration, quick action self-locking brake, etc. A special feature of this machine is the patented method of mounting the motor, which considerably reduces the oscillation of the basket due to an out-of-balance load.



Single Action "Broomwade" Vacuum Pump.

and boosting, and also for vacuum exhausting, this latter type being in large demand, especially for primary pumps where they are able to deal effectively and quickly with the most intricate systems of pipe work. Another purpose for which

Cambridge Instrument Co. Ltd.

AMONG new instruments brought out in 1932 by the Cambridge Instrument Co. is the direct reading *pH* meter which is a distinct advance upon the apparatus hitherto available. The glass electrodes can be supplied in a slightly modified form which renders them particularly suitable for use in conjunction with a recorder for securing continuous records of fluctuations in the *pH* of a solution. Another new instrument is the moisture meter, which operates electrically, due to the high dielectric constant of water, which may be present in the material used. The new illuminated moving scale indicator, the Cambridge precision gauge for draught and pressure, the Cambridge illuminated dial gauge, and a new portable pressure recorder for waterworks and gasworks engineers, are instruments of considerable interest. The company's pressure and vacuum recorders have been recently modified in design, and are more robust than previously, while the accuracy remains unimpaired. In connection with the temperature measuring instruments, there have been developments in the instruments of the mercury-in-steel pattern.

Cellactite and British Uralite, Ltd

THIS firm manufactures Uralite sheet, the original composition sheeting often used for a hot plate because, unlike the asbestos-cement sheet of later introduction, it withstands high temperatures without cracking. Of possibly greater application in chemical industry is Cellactite, a steel-cored corrugated roofing sheet, proof against corrosion even under bad conditions, and possessing special drip preventing properties. This is a roofing that cannot flake, and this, with its permanence, is leading to its increasing use wherever contamination of manufactures by drip or flaking is a danger.

Cellactite and British Uralite, Ltd., is also rapidly developing its output of Uralite pipes, ducts and fittings. Ducting for ventilation, air-conditioning and fume removal constructed in this material is as lasting as the building itself.

The Chemical Engineering and Wilton's Patent Furnaces Co. Ltd.

THIS firm has designed and placed on the market a vacuum drying plant for the production of sulphate of ammonia. This vacuum drying plant has rendered the whole installation self-operative, and it is possible to reduce the cost of manufacture of sulphate of ammonia to a figure in the region of £3 per ton. The vacuum drying plant is to be exploited in 1933 in the chemical industry, this company having felt that in tackling the sulphate of ammonia problem it has tackled the hardest problem first.

Sulphur emissions from power station chimneys have been much to the fore in recent years, and the company was called upon to erect a plant in a large power station for the removal of 90 per cent. of the sulphur emissions from a chimney which was attached to a boiler evaporating 150,000 lb. of water per hour and able to produce an effluent which was practically clear water. The sulphur was removed in solid form.

The collieries and coke ovens have been in trouble in regard to cost of production. Large tips and heaps of refuse have been lying about unused and unwanted. The moisture content was so high (50 per cent.) that nobody would tackle it from a fuel point of view. However, this firm installed a set of forced air draught furnaces at a large colliery in Yorkshire, with very successful results.

Clensol, Ltd.

THE Clensol household water softener and purifier has recently been placed on the market with good results. It is made up in the form of a small brick, and by inserting one of these in the supply tank at the top of the house every fortnight, will obtain pure, soft, water suitable for drinking, cooking and washing, the boilers and pipe-lines would be kept free from scale and deposit and the sanitary system automatically cleansed, including drains, basins, etc., and the cost for an ordinary sized house would be less than 1d. per day. Besides this treatment for removing scale and deposits, Clensol, Ltd., manufacture a powder composition, Industrial Clegris, used for removing grease and oil from all types of marine and industrial plant.

John Dickinson and Co. (Bolton) Ltd.

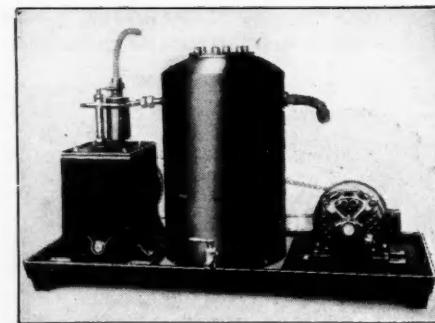
AS a subsidiary to their well-known "Aciteneo" acid resisting asphalte John Dickinson and Co. (Bolton), Ltd., have introduced, after several years of experiment and research, a range of bituminous paints under the trade name of "Durasol." Primarily of utility value, these paints also enhance the appearance of all wood and metal work treated with them. Their object, of course, is to protect from acid action and other corrosive influences, such as sea water and the outside atmosphere, surfaces which for reasons of accessibility or economy cannot be efficiently covered with "Aciteneo." Initially they are not unduly expensive and in practice will save their cost many times over.

Dunlop Rubber Co. Ltd.

THE Dunlop Rubber Co., Ltd., has recently extended its activities to another sphere of industry. The resources and wealth of experience possessed by this firm are being applied to the problem of acid corrosion, and Dunlop now offers a complete service in the supply of anti-corrosion rubber plant. Among the smaller lines there is an interesting range of utensils, patented under the name "Nerflex," made of corrosion resisting rubber. These utensils embody special flexible construction, the main feature of which is a shock absorbing core of stout fabric. This makes the utensils flexible and enables them to withstand the hard usage associated with factory conditions without risk of breakage. The interior of "Nerflex" utensils is finished with white rubber, which allows dirt and foreign colouring matter to be detected immediately. This feature is especially valuable in dye houses, where frequent changes of colour are necessary. Each utensil is fitted with a strong handle, and is reinforced at all essential points.

W. Edwards and Co.

W. EDWARDS AND CO., Denmark Hill, have been making and supplying vacuum pumps to chemical works and laboratories for many years. Beginning with a single motor driven pump they have extended their range until it comprises over 60 different types and sizes, many of them developed during the past year and varying not so much in principle—for the motor driven rotary oil type remains the best for all purposes—but in capacity, vacuum attainable, and other details which may mean much to manufacturing and experimental work. Recent developments have been in the direction of still lower pressures and higher capacities from single pumps, also special devices and auxiliary apparatus. This all leads to



Vacuum Pipe Line Installation.

lower production costs and higher output. The new A3 single stage pump gives a vacuum of 0.1 mm. with the high capacity of 7,500 c.c.s. per second and the B2 two-stage pump united with a high capacity of 3,750 c.c.s. per second a low vacuum of 0.0001 mm. Edwards's vacuum pipe-line installation has been further improved and it is now possible to get down to a vacuum of 0.01 mm. Motor driven stirrers are being increasingly used and Edwards and Co. have developed a silent running model with perfect speed control. The general experience of the firm is that the use of vacuum processes in the chemical industry has been much extended during the present business depression.

Thomas Firth and John Brown, Ltd.

FIRTH Staybrite steels are being supplied in increasing quantities in various branches of the chemical and allied trades. In the production of nitric acid by the oxidation of ammonia, Staybrite steels are used both in this country and abroad on a large scale, and are replacing ceramic materials and steels, giving longer life and increased safety. Items of equipment comprise oxidisers, coolers, absorption towers, storage tanks, transport tanks, drums, pipe-lines, valves and other auxiliary plant. Salts such as ammonium sulphate, (neutral) copper sulphate and nickel sulphate are being successfully produced by means of Staybrite plant such as crystallising tanks, filters, etc. With regard to nitrating process, Staybrite steel is being used for various parts of plant dealing with mixed sulphuric and nitric acids in the explosives and nitro-cellulose industries. Steam jacketed vessels, mixers, storage tanks, etc., in Staybrite steel have shown great advantages over other metals or glass-lined vessels for the manufacture and storage of fine chemicals and pharmaceutical products.

The General Electric Co. Ltd.

THE design of electric motors for use in gasworks is beset with many problems, of which probably the more important is that of enclosing the motor in such a way that it will give efficient service in the dusty surroundings in which it may have to operate. Dust is one of the biggest enemies to the satisfactory running of electric motors, so that for situations where dust is prevalent it is essential that the machines shall be dust-proof. Previously totally enclosed motors were used, which, although suitable for small outputs, had to be of excessive dimensions to ensure adequate cooling when larger outputs were required. This difficulty is overcome by the "Witton" frame-cooled motor, manufactured by the General Electric Co., Ltd. An interesting installation is that at the Vancouver Gasworks, where "Witton" motors totalling some 500 h.p. have been supplied.

Haughton's Patent Metallic Packing Co. Ltd.

THIS firm, one of the earliest in this country who specialised as chemical engineers, have during the past year completed much study on the development and application of acid resisting metals and chemical plant equipment to resist corrosion. Regulus metal fittings, which the Haughton's Co. manufacture, still continue to be very widely used for sulphuric acid and acid gases, as well as sulphuric acid pumps, manufactured in similar material.

The application of Ironac acid resisting iron is continually finding new developments. For some time past this company have been engaged on the equipment of acid pipe lines for sulphuric and nitric acids, made in Ironac metal, as well as large vessels for metallurgical processes, involving the use of both nitric and sulphuric acids. The explosives industries were in the past among the largest consumers of Ironac acid resisting iron, but some of the large synthetic nitrogen works now rank as important customers. A new type of Ironac metal full flow regulating valve for nitric and sulphuric acid has been designed by the firm and is likely to be in request for the synthetic nitrogen industry. Apart from the chemical industry proper, Ironac metal, on account of its intense hardness, now receives a very widespread application for use in resisting abrasion, and is particularly suitable for pipe work conveying sand, gravel, gritty substances, abrasive crystals, or for the manufacture of castings which are subjected to very severe wear and tear from erosion—this metal being practically glass-hard and a form of white iron has remarkable resistance against mechanical wear or abrasion.

Hopkin and Williams, Ltd.

DURING the past year Hopkin and Williams, Ltd., have published a new volume entitled "Organic Reagents for Metals," which deals with a number of organic substances which, during comparatively recent years, have found wide application in the detection and estimation of metals. The sensitivity attainable with these reagents in many cases far exceeds that of the older technique, whilst in gravimetric and volumetric analysis their use will frequently afford a more convenient and accurate method. Since a number of these reagents form coloured compounds with certain metals they readily lend themselves to colorimetric technique. Each

reagent has been re-investigated in the research laboratory of Hopkin and Williams with a view to making the information offered absolutely reliable. The methods are concisely described, and to the reader interested in specialised applications the comprehensive bibliographies, which follow each monograph, offer a ready means of tracing the original literature.

Howard and Sons, Ltd.

DURING 1932 much work has been done by Howards and Sons, Ltd., on improving the existing processes of solvents manufacture with the principal object of raising the quality in each case, work which is fully as important as the production of new products. A special case of improved manufacture is that of diacetone alcohol, the quality of which has been so greatly improved in all directions beyond that of any quality ever made hitherto, as to make it worthy of being considered practically a new solvent. Flash-point, solubility, colour and general stability are now greatly in excess of those formerly obtainable. While the above is a special case of improved manufacture the same policy has been carried out with sextone (cyclohexanone) and sextone B. (methylcyclohexanone). These two solvents now possess both a higher ketone content and quicker and more even evaporation rates than formerly. These improvements, especially the latter, have been largely responsible for the very marked increase in the use of these two solvents in the cellulose lacquer and similar trades. In the same way barkite (methylcyclohexanol oxalate) is now being produced of a higher quality than formerly.

For 1933 several new plasticisers are being put on the market. Barkite B. (dimethylcyclohexanol oxalate) is a new plasticiser for the cellulose and synthetic resin lacquer industries. It possesses outstanding resistance to light and ultra-violet radiation and its solvent powers for cotton and resins are far in excess of those of any other plasticiser on the market, and it is also considerably lower in price. Sextol stearate is another new plasticiser and is cheap, very stable and of low volatility. Certain special synthetic resins are also under investigation now.

Thomas Hill-Jones, Ltd.

ESTABLISHED over 100 years ago, there is nothing old fashioned in the methods of Thomas Hill-Jones, Ltd., to-day. Constant improvement in plant enables the company to keep abreast of modern requirements. Facilities provided by three acres of wharf, electric crane and their own fleet of lorries, ensure the efficient handling of large quantities of materials, either by road or water.

Their equipment is so constituted that they can handle small parcels for experimental use, or thousands of tons for important contracts. Chemical manufactures include charcoal, manganese, decolourising carbon and many grades of bituminous materials for road making.

The Leeds and Bradford Boiler Co. Ltd.

THE Leeds and Bradford Boiler Co., Ltd., established in 1875, deals in many types of tar distilling and tar dehydrating plants, and it specialises particularly in tar stills. The company has developed the manufacture of these to a fine art. It has gone specially into the manufacture of them with a view to turning out the best, and it presses the dome shaped plates to the tops and bottoms, also the U channel plates, at one heat in its hydraulic presses. It has also had specially designed and made a drilling machine for drilling all the holes in position after the plates are pressed to shape. The company does all the riveting up by hydraulic power, having had a special machine designed for riveting up all the dome shaped tops and bottoms, and all the caulking is done pneumatically. These improved methods ensure a high-class still. The company turns out an average of one still per week and most of the stills supplied during the past twelve months have been repeat orders.

It has also developed electric welding as a means of fabricating steel plate work, and its welders have been specially trained to turn out high-class welds. This method is in some cases preferred and is suitable for certain jobs. With both riveting and welding plant the company is able to cater for all requirements.

The firm also deals in vacuum drying and pressure impregnating vessels, high pressure steam separators, and many

kinds of chemical plant made of steel plates. Amongst these may be mentioned crystallisers, melters, etc., for sugar mills, various types of pans for soap works, tubes for tube mills and plant for acid works and explosive manufacturers, rubber manufacturers, paper manufacturers and others.

Kestner Evaporator and Engineering Co., Ltd.

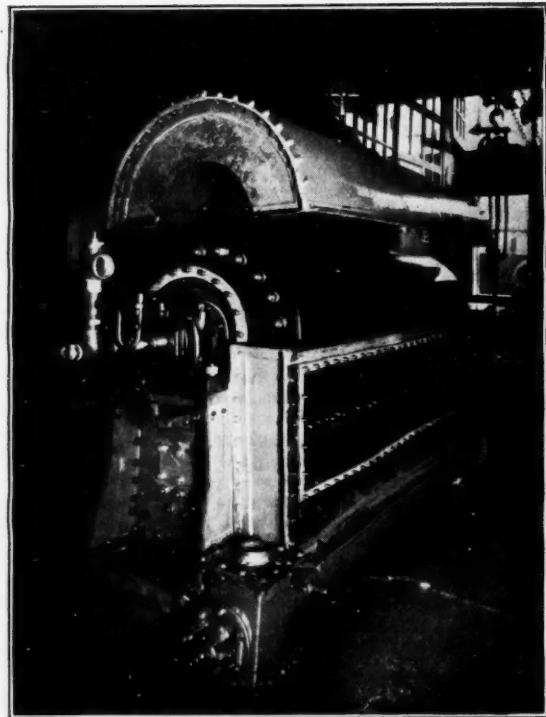
DURING the past twelve months the Kestner Evaporator and Engineering Co., Ltd., have been making considerable advances in a number of directions in their various types of chemical plant, and in particular with the utilisation of electricity in chemical processes. Installations of considerable importance have been erected wherein electricity is a source of heat. Plants have also been erected in which high temperature and high pressure autoclaves are under automatic thermostatic control, the whole unit being electrically operated. The simplicity of an installation of this type, where practically all labour of any kind is eliminated, has more than balanced the higher price paid for electricity compared with other fuel in a particular locality.

In the manufacture of oils, varnishes and similar products and, in particular, the newer types of synthetic materials, the latest Kestner patent system have been adopted, whereby high temperatures can be quickly reached, maintained for a given period, then lowered, and afterwards raised still further and again maintained for a given period—the whole being practically automatic in control and operation. One of the many advantages of this type of plant is the entire avoidance of any over-heating, which causes deterioration of the product, as found in other methods of heating. Further, owing to the high efficiency the cost of heating is often comparable with, if not lower than the use of direct firing, apart from the other advantages that are obtained, which also result in lower costs.

For the drying of numerous materials ranging from

and handling, is naturally of great importance to industry at this time.

Progress continues to be made in evaporators of various types, including the use of forced circulation, in which the

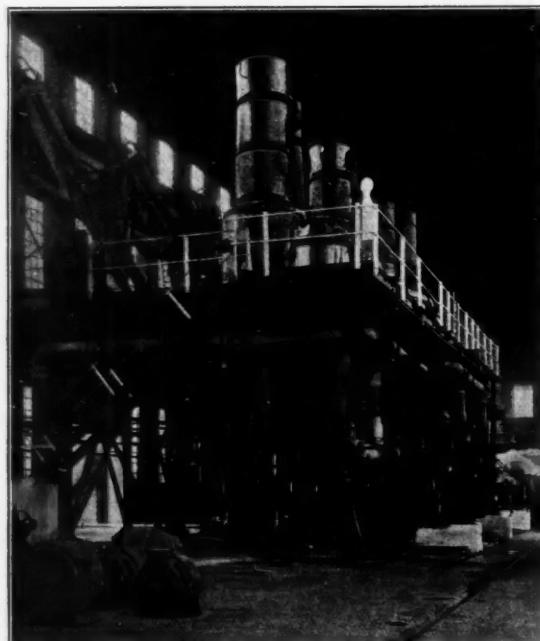


Kestner Patent Film Drier (Special Enclosed Type).

Kestner Evaporator and Engineering Co. were the pioneers in this country, where large units have been in operation for a number of years. Continued attention has been paid to the erection of installations working on new and special processes, which have in many cases been developed in their own experimental works.

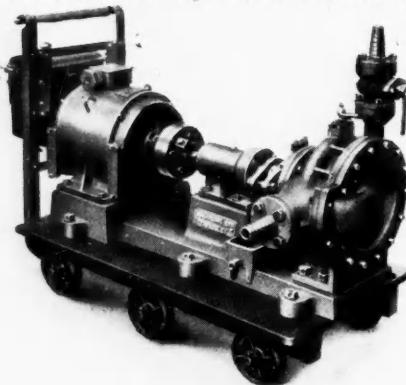
Meldrums, Ltd.

THERE has been a continuous demand for the chemical specialities of Meldrums, Ltd., which are represented in the main by their manufacture in "Meldrum Metal." A number of re-action vessels of large size have been manufactured for the North of England, the trial vessels previously



Kestner Patent Forced Circulation Triple Effect Salting Type Evaporator.

delicate foodstuffs to heavy chemicals, the Kestner patent spray drier and film drier are still making headway, the units which they have erected showing a great efficiency both in running costs and ease of control. It has been confirmed in actual practice that by the unit operation of spray drying, solutions can be dealt with so as to produce a final powdered product in one operation, thereby effecting great improvement over existing processes, which comprise filtration, drying and subsequent grinding. The substitution of a single plant unit for several processes, requiring appreciable labour



Portable Meldrum Metal Pump.

supplied having proved satisfactory in operation under heavy conditions. These vessels were of considerable size, weighing over 2 tons each. Owing to improvements in manufacture these vessels in high silicon iron will stand rapid cooling to

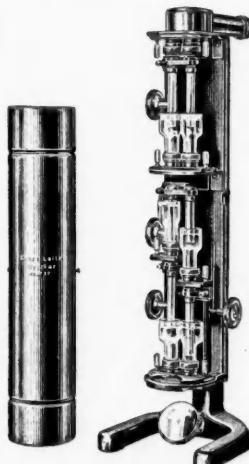
keep the temperature within specified limits. There has been a steady demand for their latest design of centrifugal acid pumps. The double inlet impeller now employed gives freedom from gland leakage, and the necessity for thrust bearings is eliminated. These pumps are resistant to sulphuric, nitric, acetic and hydrochloric acids. A type of cock well favoured by dye manufacturers and artificial silk works and chemical works generally is a gland cock, the body of which is made of regulus metal and the plug of "Meldrum Metal." The "Meldrum Metal" plug, being extremely hard, takes a mirror like finish, turns freely and does not stick. A considerable amount of work has been done for Russia in the shape of nitric acid concentrating towers.

The good prices now obtainable for benzol have resulted in extensions to plants in the North of England involving the use of Meldrum scrubbers for the extraction of benzol and ammonia. Steel vessels homogeneously lead lined for refining of oil, and plant for silver refining have been called for during the year.

E. Leitz (London)

All Leitz colorimeters can be used for absolute colorimetry, *i.e.*, colorimetry without a colour standard. Use is made of a true neutral grey filter in liquid form, the extinction coefficient of which is $e = 0.5$ per 1 cm stratum. Eleven monochromatic filters fitted in a rotating disc are used. In addition to the facility for reading directly the extinction coefficient of the test solution on the scale attached to the colorimeter stand (this was not possible hitherto with any of the instruments on the market), Leitz absolute colorimeters are excellently suited for graphing the absorption curves of dyestuffs and of colour in sera and urine. The new arrangement for absolute colorimetry makes the ordinary dipping colorimeter a spectral-photometer, with the advantage of a larger and brighter comparison field and a testing vessel with variable stratum adjustable to suit the various colour intensities of the solution under test. The usefulness of the Ultropak Illuminator, manufactured by E. Leitz, for the examination of opaque matter has been further extended this year, by the addition of dipping cones by which it is possible to investigate objects which are immersed in liquids, under the highest and lowest powers. Wet surfaces can be conveniently viewed without glare arising.

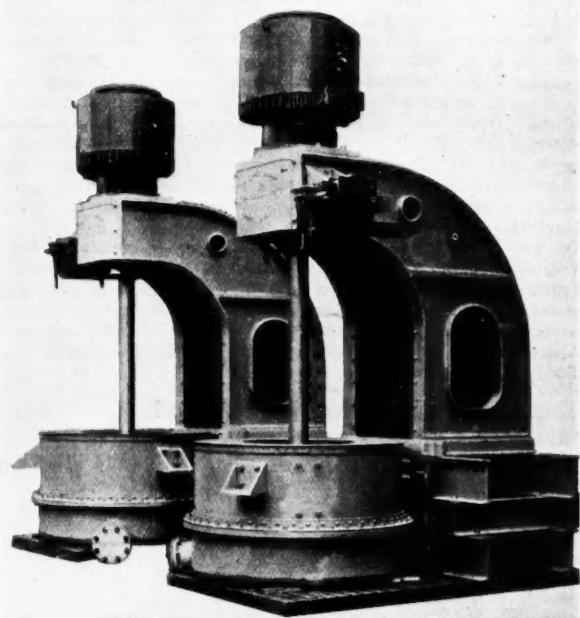
The Leitz metallographic microscope MM, which may be used for observations with the ordinary vertical illuminator (glass plate and prism on one spindle) as well as for dark-ground illumination, and, on request, polarised light, now has a rival in a smaller outfit consisting of the same microscope stand and optical equipment, but with the camera and the lamp fitted to a common cast iron base. The arrangement thus takes up considerably less space, and is recommended in cases where funds do not allow of the purchase of the large outfit or resilient vibration absorbing device, which latter, now as before, is the most ideal apparatus for routine as well as research work in industrial laboratories and institutions. The simplified metallographic microscope MM is fitted with a built-in filament lamp which yields sufficient intensity even for photo-micrography at $\times 1,000$ and beyond, without unduly lengthening the time of exposure. The objectives used with the Leitz metallographic microscope, whether the large or small model, are corrected for infinity, and mounted in tubular sockets, and may be used for bright field and dark field observations. The change-over from one mode of illumination to the other takes place whilst the objectives remain stationary and in focus, so that one can conveniently view a particular portion of the specimen by both modes of illumination.



Leitz 3-stage Colorimeter for pH determination, with compensating arrangement.

NOTWITHSTANDING the tendency among some chemical engineers, owing to the depression, to turn to the use of metals of construction cheaper in initial cost, high-grade materials such as pure nickel, Monel metal and the nickel-chromium stainless steels have continued to find wide application in the chemical industry where plant is handling highly corrosive substances. A pure nickel ebullition chamber, 23 ft. long by 5 ft. diameter and weighing 4½ tons, for the concentration of caustic soda liquor, and two of the largest Monel metal centrifugal baskets yet made and recently supplied to the new Ford Works, at Dagenham, may be cited as outstanding examples of the use of the two former materials.

Among the newer materials, principal interest attaches to nickel-clad steel plate and nickel-coated steel sheet and strip. Up to the present, these composite metals, which consist of nickel rolled on steel, have only been available from foreign sources, and British manufacturers have been loth to adopt materials not made in this country. During the past year, however, a number of British firms have been experimenting



Centrifugals equipped with Monel Metal Baskets and Monitors, as supplied for the new Works of the Ford Motor Co., Dagenham.

with the rolling of nickel-clad steel, and there is little doubt that in the near future supplies will be commercially available.

The need for economy has undoubtedly helped to foster the development of the austenitic nickel cast-irons, which besides possessing good resistance to corrosion, are easily cast and readily machinable. Castings in these alloy irons are generally cheaper than those in brass or bronze and frequently give a much longer life. The austenitic nickel cast-irons present the most satisfactory materials for many plant parts, such as pump castings and valves handling corrosive materials, and have been found to be especially resistant to the action of caustic solutions and weak sulphuric acid. A special nickel-copper cast-iron which is believed to harden rapidly with light work on the surface has been advocated for conditions where erosion as well as corrosion is met. Pump castings in this alloy are reported to give excellent service for handling "triple effect" liquor, *i.e.*, liquor carrying crystals in suspension. A new nickel-chromium alloy containing approximately 14 per cent. of chromium has recently been developed in America, to meet the particular conditions in the dairy and food handling industries. This alloy was selected after exhaustive experiments on a large number of materials as the most suitable for the purpose.

L. Oertling, Ltd.

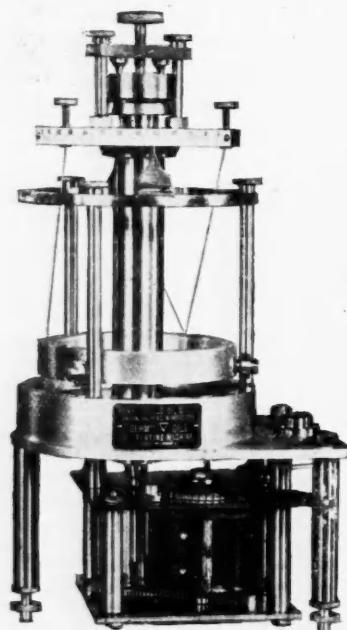
THIS firm of British balance manufacturers has introduced a number of chemical balances of new design particularly suitable for rapid and accurate weighing. The model which results so far indicate as being the most important development is their Aperiodic prismatic reflecting balance. This combines a sensitivity to 0.0001 grams with the quick reading introduced by an air-damping device. When the balance has come to rest milligrams and tenths are read direct off an illuminated scale, the enlarged image of which is projected by an electric light and optical system to a convenient position at the top of the balance case. Provision is made for fitting this model with oil-damping instead of air-damping if preferred.

The Paterson Engineering Co., Ltd.

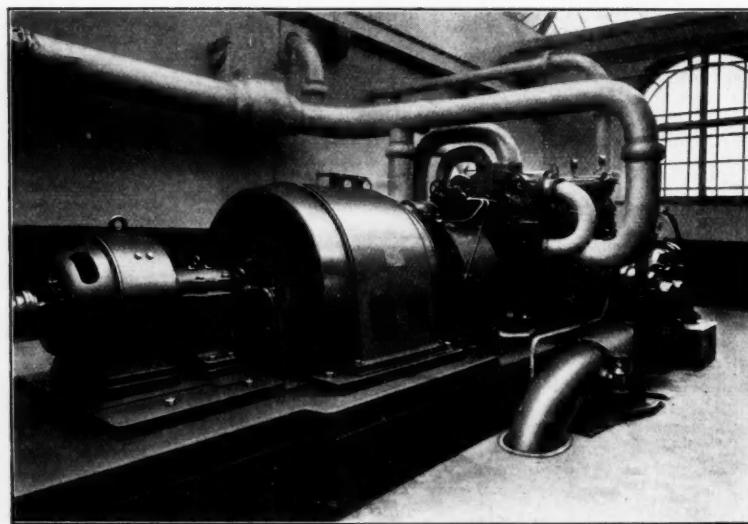
FROM the point of view of the chemical industries one of the chief contributions of the Paterson Engineering Co., Ltd., is its world-wide work in the use of liquid chlorine for sterilising water supply, sewage, and sewage effluents, water used in swimming baths and for the cooling of condensers in connection with steam turbines and engines. One of the latest "Paterson" installations is for the town of Alor Star, which is the capital of Kedah State, in Malay. This is an example of the great value of chlorine gas in sterilising badly-contaminated drinking water, which otherwise it would be impossible to use. The raw water is mixed with sulphate of alumina and lime on the coagulation principle and is then filtered through six "Paterson" horizontal, closed pressure, sand filters. Each of these is 20 ft. long and 8 ft. diameter, the duty of one of the pumps being taken by three filters, with cleaning by means of compressed air, the same sand lasting for several years. Sterilisation is carried out by two Pulser type "Chloronomes," which deliver continuously and automatically a measured trace of chlorine gas, approximately at the rate of 1 part of chlorine per 2,000,000 parts of filtered water, along with one grain of sulphate of alumina and lime, so as to give a final slight trace of alkalinity in addition to complete sterilisation, with no *Bacillus coli* in 100 c.c.s.

Germ Lubricants, Ltd.

GERM LUBRICANTS, LTD., have recently developed an interesting portable instrument on which it is possible to show the different frictional effects obtained with lubricants which are



Friction Measuring Apparatus developed by Germ Lubricants, Ltd.



Metro-Vick Self-Contained Turbo Generator.

rich in "oiliness" and super-refined oils such as toilet paraffin, transformer and certain turbine oils, all of which are somewhat deficient in "oiliness." It can be demonstrated in a few moments on this machine, that the majority of pure mineral oils are much superior in "oiliness" to the super-refined oils, but that the animal and vegetable oils show a marked superiority. The "Germ" and "Argon" brands of oils, made on the Wells-Southcombe patented process (with the addition of organic acid), stands in a class by themselves and show the highest degree of "oiliness" and lubricating efficiency yet attained. These instruments are not yet being made for general use, though a few models have been sold to Government departments and technical institutes in different parts of the world. Demonstrations, however, can be arranged through the offices of Germ Lubricants, Ltd., or their agents.

Metropolitan-Vickers Co. Ltd.

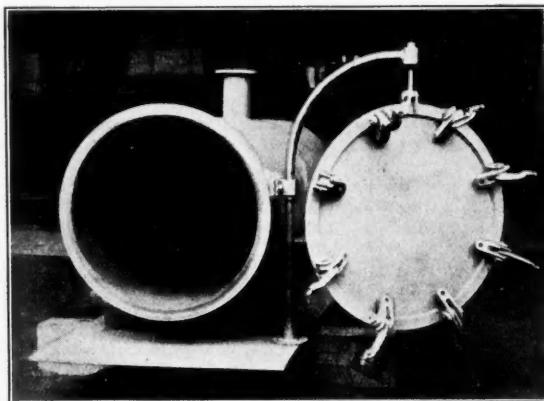
SELF-contained turbo-generators, since their introduction by the Metropolitan-Vickers Electrical Co., Ltd., have found application in all parts of the world and in practically every branch of industry by reason of their advantages for small and medium sized installations. They are admirably adapted to the needs of the chemical industry, particularly when arranged as "pass-out" machines supplying not only electric power but also clean process steam, through the medium of the one installation. Recent orders placed with the Metropolitan-Vickers Co. for plant of this type include that for an installation to be made in a new power station for the Monsanto Chemical Works, Ltd., Ruabon, North Wales.

Process steam for these works was originally obtained from boilers operating at 155 lb. per sq. in. g. and electric power from an external supply system. New boilers are being installed for a pressure of 450 lb. per sq. in. g., 800° F. superheat to operate two Metro-Vick self-contained turbo-generators, each comprising an 850 kW m.c.r. turbine driving a 3,300 volt, 3-phase, 50 cycle, alternator through gears giving a speed reduction of 7,500/1,000 r.p.m. Process steam will be bled from the turbine at the original process steam pressure at 155 lb. per sq. in. g. The high tension and low tension switchgear and other electrical equipment of the power house will also be supplied by the Metropolitan-Vickers Co.

A Metro-Vick self-contained turbo-generator is also being installed by the Ocean Chemical Co., Ramsbottom, to supply current for the electrolytic production of caustic soda. This unit will comprise a 650 kW m.c.r. turbine driving a 600 kW m.c.r., d.c. generator with a voltage range of 300 to 600 volts, and on the same shaft a 50 kW, 0.8 p.f., 400 volts, 3-phase, 50 cycle alternator providing power for motors, lighting, etc.

Oxley Engineering Co. Ltd.

THE Oxley Engineering Co., Ltd., Leeds, makes a speciality of homogeneous lead coating vessels of all descriptions for the chemical trade, and has carried out a number of important contracts. By its process it guarantees the lead coating to be homogeneous and non-porous, suitable for vacuum or pressure. The company also designs and makes all kinds of steel vessels for the chemical trade in either welded or riveted construction. This enables it to offer a complete specification, and has the important advantage of enabling it to homo-



An Electrically Welded Steel Retort.

geneously lead coat intricately designed vessels before being assembled finally, which, otherwise, would be difficult to do.

Other lines are condensers, jacketed pans, and boilers for all pressures, mixers, etc., in either mild steel or cast iron. The illustration shows an electrically welded steel retort. The lid is fitted with the Hollis patent quick-grip fastener. For many years the firm has been engaged in the manufacture of tar distilling plant of all descriptions. Its "three-piece" tar stills, with the bottom, shell and top each in one plate, all electrically welded, have proved successful, and large numbers have been supplied with satisfactory results. Benzol stills (fire and steam heated) naphtha stills, and subsidiary plant, cooling towers, etc., have also been supplied and erected. A large number of storage tanks, some riveted, and others electrically welded, have been built by this firm.

Redfern's Rubber Works, Ltd.

THE advantages of ebonite for the lining of tanks and in many forms of factory equipment, have led many manu-

facturers in the chemical industry to use it more freely. The accompanying illustration shows a section of a mild steel

road tank for carrying hydrochloric acid, the weight of which when loaded is approximately 4/5 tons. The size overall is 8 ft. 6 in. and the diameter 4 ft. 7 in. This tank was lined with a 3 ft. 6 in. layer of Redfern's acid resisting ebonite throughout, and the manhole and the manhole cover were lined and covered complete with rubber joint ring. The factory equipment available in Redfern's "Bulwark" ebonite includes pipes, bends, cross and tee pieces, taps, gland cocks, injectors, hand pumps, funnels, buckets up to 5 gal., jugs, measures and ladles.

In addition to the progress which has been made during the year in the manufacture of ebonite goods, the mechanical rubber department of Redfern's Rubber Works, Ltd., has also developed in many directions. The progress which has been made by the rubber trade in the manufacture of rubber goods which are resistant to heat, acids and certain oils, has led to increased efficiency in many trades and has contributed to the progressive development of manufacturing practice.

Siebe, Gorman and Co., Ltd.

THE protection of the health of the worker is one of the most vital problems of the chemical industry. Gases, fumes, poisonous and harmful dusts must be properly guarded against in every efficient chemical organisation. The firm of Siebe, Gorman and Co. offers a complete service to employers who desire to equip themselves with the most up-to-date and efficient appliances. Continuous research is carried on with a view to producing safety and protective apparatus which will meet every requirement of the chemical industry. "Everything for Safety Everywhere" indicates the scope of the company's activities. It has been found that valuable educational work is possible by lectures and demonstrations which stimulate the minds of workers and inculcate a "safety-sense" which has far-reaching effects. The company's expert representatives have delivered a number of these lectures in various parts of the country, and to them are invited all those who are interested in safety. Any firm which wishes to direct the attention of its employees with special force to this important problem is invited to communicate with the company.

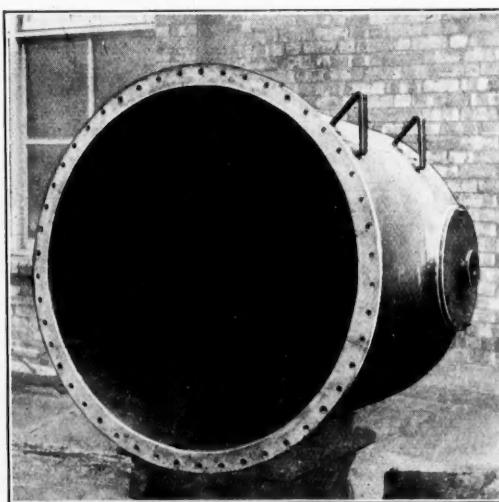
Silica Gel, Ltd.

DURING 1932 Silica Gel, Ltd., have received a large number of orders, and interest in silica gel is still growing. The dehydration of air and gases by silica gel, both at atmospheric pressure and in the compressed state, is of chief importance. The work is done by apparatus ranking in size from the small 2 in. diameter desiccator to plant drying thousands of cu. ft. per minute. Further uses for desiccators have been found in connection with the shipment and storage of hygroscopic articles that must be kept dry, and in the prevention of corrosion or general damage due to moisture in delicate instruments of various kinds. Their sizes increase gradually to small plant units for similar or related purposes. In the large plant sphere an outstanding item is the success of the silica gel process of drying as applied to the withering of tea leaf, and this has to a large extent been brought about by the development of a continuous type absorber which reduces the amount of gel required for a specific duty to the lowest possible. In the air conditioning field this type of plant promises a widespread adoption. Not only in air dehydration plants, but also in solvent recovery plants considerable progress has been made in the design and construction of equipment.

George Scott and Son (London) Ltd.

AS there has been little or no call for the extension of equipment in factories concerned with established processes, during the lean year now drawing to a close, George Scott and Son (London), Ltd., have been chiefly engaged in the development of new fields of enterprise. Inquiries for chemical process plant were never more prolific nor so varied. This has led to the study of many original schemes and the preparation of many new designs of equipment. With the return of world confidence it is, therefore, reasonable to expect the materialisation of many carefully planned projects.

During the year there have been considerable developments in the food industries. The firm has supplied several notable installations for the condensing of milk in the Scott patent forced circulation evaporator. These plants have been



Section of Mild Steel Road Tank lined with Acid Resisting Ebonite.

installed by enterprising companies in preference to the now obsolete coil type of evaporator with its inaccessibility for cleansing, its inefficient circulation and the close control which this old-fashioned design demands. They have appreciated the outstanding attractions of the new design, with its ease of access for cleaning and sterilisation, its evaporative efficiency and elasticity in batch operation. They have also supplied plants for other food products, certain of which had not hitherto been concentrated except in the single effect type of evaporator. In several instances, by the embodiment of new features, the concentration of even the most delicate liquors has been successfully effected in double effect. The Scott patent vacuum band drier, in which it is possible not only to dry but to grind the dried product under high vacuum conditions, thus attaining the hygienic ideal, has met with increasing favour, particularly in the manufacture of food stuffs. They have also added to their range of solvent extraction plants.

Sofnol, Ltd.

DURING the past year there has been a steady increase in business in water softening materials, and Sofnol, Ltd., have established a department for the sale of pure hydrated lime fertilisers and weed killer for horticultural purposes. This department, they state, is making rapid and satisfactory progress. The firm manufactures calcium hydrate—lime-soda mixture, accurately compounded for softening any water supply, soda lime, sofrolite solid gravimetric CO_2 absorbent for analytical use, apparatus and reagents for water testing, indicators for accurate titration, including special mixed indicators "Sofnol red" and "Sofnol purple," and special soap for hardness testing.

Staveley Coal and Iron Co., Ltd.

THE chemical trade in 1932 has been somewhat better than it was in 1931. There are signs of improvement in various trades, and it is particularly noticeable in the demand from the textile trades. In spite of this, however, there is keen competition amongst the suppliers of chemicals to the textile trade and in some instances prices are being cut to an uneconomic level.

The demand for sulphuric acid has decreased during the year owing to the fact that so many gasworks and coke ovens considerably reduced or ceased altogether to make ammonium sulphate in consequence of the low price ruling for that fertiliser. Now that better prices are obtainable for sulphate of ammonia, it is to be hoped that we shall soon see all the by-product sulphate of ammonia plants again in operation, as it must be in the national interests to convert the ammonia into a fertiliser rather than to poison the land, rivers or the air in an attempt to get rid of the ammoniacal liquor. The low output of tar due to the bad state of trade in the iron and steel industries has been largely responsible for some substantial advances in the prices of many of the tar products. A notable exception, however, is cresylic acid, which, during 1932, has been difficult to dispose of at any price. During the year the Staveley Coal and Iron Co. has put into operation a new type of plant for the manufacture of bleaching powder.

J. W. Towers and Co. Ltd.

ON August 18 of this year J. W. Towers and Co., Ltd., celebrated the jubilee of the foundation of the firm. Since then rapid progress has been made. According to the Jubilee number of "The Tower Messenger"—their monthly leaflet issued free of charge to all who use scientific apparatus—the manufacture of acids was begun in 1887. Nowadays the acids manufactured by them are of unsurpassed purity. Their nitric acid, for example, is so pure that contact with glass is detrimental to it, and consequently it is sent out in wax-lined bottles. A recent introduction is a range of all-British balances, under the name of "Victor," and another new line is standard interchangeable ground glass joints. A new improvement in the hydrometers is a device to prevent the scale from slipping.

George Waller and Son, Ltd.

GEORGE WALLER AND SON, LTD., of Phoenix Ironworks, Stroud, have recently patented and put on the market the "Phoenix" double faced valve which embodies entirely new

and interesting mechanical features. The outstanding features are no springs or internal pins to perish or break; the doors rotate when opening and closing, keeping the faces clean; great pressure is exerted on closing, thus ensuring absolute tightness of the valve. The valve can be opened and examined while the doors are closed and under pressure.

Miscellaneous

ADAM HILGER, LTD., have developed several new types of precise optical instruments for research and control of chemical and other processes during the year. Among these the principal are new instruments for the investigation of spectro-photometric absorption curves of substances, the Spekker spectrophotometer, the Judd Lewis comparator, the Hilger Louvre strain viewer and the Williams-Rayleigh interference refractometer.

FILTER PAPERS for laboratory work and in qualities to suit all industrial purposes have been made by Evans, Adlard and Co., Ltd., for upwards of 50 years. The company's "Postlip" filter papers are supplied in sheets, circles, folded circles and rolls, and are fully described in a brochure which may be obtained on application to the company.

MAYHEW, RAMSEY AND CO., LTD., report that there are now over 16,700 of their "Miracle" mills in use in various parts of the world. These mills are employed in grinding an extraordinarily wide range of materials, including cereals, spices, soya beans, grasses, cotton and compressed cake, fish scrap, fertilisers, hoofs, horns, meat and bone, potash salts, chemicals, limestone, chalk, etc.

REDLER PATENTS write:—"In spite of the depression we have had a good year and our machines have such a wide appeal in these days of labour-saving that we are entering on 1933 with a book full of orders and our men are on overtime. We have, however, speeded up production and, with the co-operation of excellent licensees in various industries, we can promptly cope with all the orders which chemical manufacturers send us. Here's to brighter times and big business."

The Society of Chemical Industry

A Difficult but Active Year

THE Society of Chemical Industry is not alone in regarding 1932, its fifty-second year, as one of the most difficult in its history. The troubles that beset the industrialist do not leave scientific societies untouched. The Society has proved its hold on industrial chemists by retaining all but 2.8 per cent. of its members. The year has been full of activity, the chief event being the annual meeting organised by the local section at Nottingham during July. The arrangements were excellently carried out by the local officials, and the hospitality of the University, civic authorities and local firms compared favourably with the meetings held in more prosperous times. The outstanding addresses were Professor G. T. Morgan's presidential address on "Ourselves and Kindred Societies," and Sir William Pope's Messel Medal Lecture on "Forty Years of Stereochemistry."

All the local sections carried out full programmes and in many cases made some progress towards rationalisation by opening their meetings to members of other societies and in some cases arranging joint meetings. Altogether some 150 meetings were held in the home districts, while the sections overseas were equally busy.

One of the notable features of the year's work was the creation of two new subject groups dealing with plastics and food respectively, and the present policy of the Council is to increase the number in order to cope with the individual requirements of the divisions into which chemistry is now separated. Immediate success attended the new series of Jubilee Memorial Lectures. Three of these were delivered during the year, viz., "Fluid Fuels To-day and To-morrow" by Dr. A. E. Dunstan; "Corrosion of Metals in Salt Solutions and Sea Water" by Dr. G. D. Bengough, and "Alcohol through the Ages" by Dr. E. F. Armstrong.

The Society is taking a prominent part under the presidency of Dr. R. H. Pickard in probing every prospect of securing in the near future some form of combination or co-ordination of our chemical associations.

Edible Fat and Oil Control Conditions in Germany

ALTHOUGH satisfactory conditions may prevail in the butter, margarine, lard and edible oil industry in Germany, the supervision exercised by the responsible State Departments must necessarily continue because of the great importance to the national economy of these heat-giving and generally valuable foodstuffs. It is possible to produce materials which are not quite up to standard or do not comply with the provisions of the law and the public requires continuous protection in the interests of the producers and the consumers. Professor A. Beythien ("Allg. Oel u Fett Ltg.", 1932, p. 477), gives a description of the experiences of the testing station at Dresden. In 1931, a total of 888 samples of different edible fats were examined, 591 tests being carried out on butter, 142 on margarine, 97 on other animal fats and 58 on vegetable oils and fats.

The water content of butter has been watched very carefully. Of samples tested 13.2 per cent. had a water content of above 16 per cent. An improvement in this direction is evident, although there is far to go before reaching the pre-war figure of 3 per cent. excess water content. During the distressing period following the inflation up to 41 per cent. of the samples of butter tested contained excessive water content. The lowest water content noted in recent years was 8.02 per cent.; the highest 25.2 with a mean for all samples of 15.02 per cent. In reference to the fact that butter, free from salt, may contain 18 per cent. water it should be emphasised that butter containing as little as 0.2 per cent. salt is considered to be salted. Experience has also undoubtedly shown that although the accurate sampling of butter is comparatively difficult, yet with care it is possible to obtain results which are within

0.3 per cent. of the mean for the water test. Butter spoiled by tallowy or rancid taste is becoming rare and comparison with old records shows that there has been a very considerable improvement in the quality of the milks used for butter making in Germany.

Owing to the high state of efficiency in the German margarine industry, there is no cause for surprise in the fact that very few samples of margarine have been found to be objectionable. The method of packing is still a question of opinion and forms a matter for argument between officials and the industry. In 1931, although of the 142 samples tested rather a large number contained too high a water content, it was found on investigation that the questionable samples all came from one factory; eleven of the samples contained more than 16 per cent. water, five of them having 17 to 20 per cent. water. Attention is drawn to the provision which states that margarine must contain some material which may be recognised chemically. Both phenolphthalein and methyl orange have been proposed for this purpose. With regard to starch, it is pointed out that potato starch, which can be used, must be evenly distributed throughout the mass of the margarine and that if sesame oil is employed care should be taken to observe the test conditions. In contrast to earlier experiences which led one to believe that margarine was a comparatively stable fat, several samples have been encountered showing signs of deterioration without an accompanying increase of acid value. In each case coconut oil was present, and the spoilage was found to be due to the phenomenon known as "perfumed rancidity" (odour rancidity).

From Week to Week

REVIEWS of the British synthetic fertiliser industry and of the work of the Association of British Chemical Manufacturers and the British Road Tar Association are unavoidably held over.

THE GERMAN DYE TRUST (I. G. Farbenindustrie) has taken on 4,000 new workers. The Steel Trust has engaged 6,000 new workers.

ACCORDING TO INFORMATION from Santiago de Chile, orders for a total of 200,000 metric tons of nitrate have been received from France, Spain, Japan, and Italy.

WORK WAS STARTED at Corby, near Kettering, Northants, on December 23 on the £3,300,000 steel development scheme of Stewarts and Lloyds, Ltd.

THE PETITION FOR THE WINDING-UP of the Non-Inflammable Film Co., Ltd., has been dismissed. The petition was originally heard on July 4, but was allowed to stand over on several occasions.

NEW WORKS ARE TO BE ERECTED at Liverpool for the manufacture of industrial alcohol. It is estimated that employment will be found for between 600 and 700 men, 80 per cent. of whom will be recruited locally.

GENERAL METALLURGICAL AND CHEMICAL, LTD., of Finsbury Pavement House, Moorgate, London, E.C.2, are the sole suppliers in this country of the products manufactured by the Carbide and Carbon Chemicals Corporation, of New York.

CHILE, WHICH IS SUFFERING AN ACUTE SHORTAGE OF PETROL, has received news that a substitute for petrol has been discovered, which can be extracted from nitrates, of which Chile is the biggest producer from natural sources. The new fuel is called "nitroline," and it is claimed that it can be produced at half the selling price of petrol.

THE AMMONIAQUE SYNTHETIQUE ET DERIVES, one of the larger synthetic nitrogen producers in Belgium, is reported to have developed a new process for the manufacture of an ammonium nitrogen-base fertiliser which is claimed to eliminate certain leaf and root diseases of plants and to be produced at prices less than competitive products now on the market.

MR. JOHN GRAY, of Tacoma, Queen's Drive, Colwyn Bay, Denbigh, at one time vice-chairman of Lever Bros., Port Sunlight, and afterwards managing director of the associated companies, William Gossage and Sons, Ltd., Widnes, and John Knight, Ltd., London, who died on September 25, left estate of the gross value of £110,283, with net personality £105,106.

MR. T. H. REDFERN, a director of Redfern's Rubber Works, Ltd., Hyde, Cheshire, has been appointed chairman of the National Union of Manufacturers (Manchester Branch) for 1933.

MR. L. D. BOTIROL, a late director, is to oppose the acceptance of the report and accounts of the Acetex Safety Glass, Ltd., for the year to June 30, 1932, and to ask shareholders to appoint a committee of inquiry.

THE DANISH STATE RAILWAYS, according to the "Ekstrabladet," is going to place an order for steel rails in Britain. The value of the order would be 3,000,000 kroner (nearly £170,000 at par), and it has usually been placed in France.

DURING THE FIRST NINE MONTHS of 1932 the production of kelp ash in Norway was approximately 48 per cent. heavier than in the 1931 period. Exports amounted to 4,815,146 kilos, an increase of 73 per cent. over the preceding year.

THE WHESSOP FOUNDRY AND ENGINEERING CO., LTD., of Darlington, and the Motherwell Bridge and Engineering Co. have jointly secured a contract for petrol storage tanks at Haifa, Palestine, for the Iraq Petroleum Company, Limited. The contract is worth £160,000. Manufacture will entail the use of 8,000 tons of British steel.

AN OFFER BY THE TRUSTEES of the late Viscount Leverhulme to contribute £2,000 a year on certain conditions to the Royal Commercial Travellers' Schools for orphans and necessitous children at Pinner was accepted at a general half-yearly court of the governors of the schools on December 28. The condition was that six children, orphans of chemists or grocers, to be nominated by the trustees, should be educated at the schools.

A COMMISSION HAS BEEN FORMED in Italy for the study of the application of olive oil as a lubricant, as proposed by the national association of olive growers. A large amount of valuable data has been collected on the action of olive oil as a lubricant in certain types of motors. These researches will be continued to help solve a problem which is of great importance to the country from an industrial, production and political standpoint.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, on December 7, re-elected the following officers to serve for 1933: Dr. J. Van Nostrand Dorr, New York City, president; A. E. Marshall, New York City, vice-president; F. J. Le Maistre, Philadelphia, secretary; Martin H. Ittner, Jersey City, treasurer. The following were elected as directors to serve for three years: C. R. Downes, New York City; Dr. H. E. Howe, Washington, D.C.; S. D. Kirkpatrick, New York City; F. W. Willard, Kearny, N.J.

THE SWEDISH MATCH CO. has begun the removal of its headquarters from Stockholm to Jönköping. The municipal authorities of that town have made a grant of 3,000,000 kr., repayable within five years, to cover the expense of the move, which will mean a heavy loss to Stockholm. Jönköping expects to receive additional revenue amounting to 152,000 kr. a year from the taxes of the company itself, in addition to taxes on the salaries of the employees. The company is believed to be reckoning on an annual income in future of 15,260,000 kr.

THE INTERNATIONAL TIN COMMITTEE states that total exports of producing countries for the past three months were: September 5,787 tons, October 5,097 tons, November 6,143 tons. The monthly quota was 5,742 tons. At the end of November, Bolivia had exceeded its quota by 1,414 tons and Malaya by 404 tons, while the Dutch East Indies was below its quota by 150 tons, Nigeria by 79 tons and Siam by 508 tons. The total excess over quota was thus more than 1,000 tons. The next meeting of the committee will be held in London on January 24.

DETAILS OF THE WORK of the Salters' Institute of Industrial Chemistry since its foundation in 1918 have been described in a report drawn up by the director of the institute. By means of Salters' Fellowships the institute enables young men from universities or similar institutions to undergo a special further training in industrial chemistry. During the last 18 months, when industrial depression has led to the cutting down of scientific staffs, no Salters' Fellow has been displaced. In some cases there is clear evidence that the special kind of training and experience that the institute prescribes has placed a Fellow at a decisive advantage.

THE PRELIMINARY BALLOT OF THE AMALGAMATED SOCIETY OF DYERS for the election of a secretary, has resulted in Mr. G. H. Bagnall, of Manchester, North-Western district organiser for the society, receiving 4,263 votes. Mr. John Dougherty, of Glasgow, the Scottish district secretary, received 2,240 votes; Alderman M. F. Titterington, Bradford, Yorkshire district secretary, 1,726; and Mr. James Harrison, Bradford, a member of the National Executive Committee, 1,064. There were 15 candidates and the total votes cast were 13,339. The four mentioned are to go to the ballot again for one candidate to obtain a clear majority over the others.

MR. A. M. WISEMAN, Trade Commissioner at Toronto, is now in this country on an official visit. He will be available at the offices of the Department of Overseas Trade on January 2-4, 1933, and also during the period January 16-24, for the purpose of interviewing firms interested in the export of United Kingdom goods to the Dominion of Canada. Subsequently he will visit a number of industrial centres in the provinces. Firms desiring interviews with Mr. Wiseman in London or at provincial centres should apply to the Comptroller-General, Department of Overseas Trade, 35 Old Queen Street, London, S.W.1, quoting the reference 15540 1-32.

IN THE HOUSE OF COMMONS on December 21, Mr. W. M. Kirkpatrick (Preston) asked leave to introduce a bill to provide for contributions by rubber manufacturers in the United Kingdom and Northern Ireland to the Research Association of British Rubber Manufacturers. The object of the measure, he said, was to secure the continuance and development of scientific and industrial research into problems arising in the manufacture of rubber which was being carried on by the association, and it had influential support. It was desired to put rubber research on a sound and practical basis. Contributions were not to exceed one-twentyfifth of a penny per pound in respect of all rubber used as such in the process of manufacture and in the form of latex. The bill limited the aggregate contribution to the average sum of £15,000 a year, and its operation was confined to five years. Leave was given to introduce the bill, and it was read a first time.

INTERESTING DEVELOPMENTS ARE TAKING PLACE in the aluminium industry and trade in the Far East. For some time negotiations have been going on for the establishment of an aluminium industry in the Netherlands Indies, and the participating companies have now founded a concern to work bauxite deposits on the island of Bintam. The new bauxite concern hopes to trade with Japan, which imports about ten thousand tons a year, chiefly from the United States. As this amount could be supplied by the new concern Japan would be rendered independent of other supplies. At the same time, there are prospects of participating in a Japanese national aluminium industry, for which the Japanese Government is said to have already promised support. The consortium also proposes to supply aluminium to China, obtaining the metal from Manchuria, where the bauxite deposits are still so large as to make it a paying proposition to start an aluminium industry there. Production by the Dutch India concern will only begin when sufficient selling territories have been assured.

SIR WALROND SINCLAIR, speaking at the annual general meeting of the British Goodrich Rubber Co., Ltd., on December 20, referred to the expansion of the company's business, and indicated the likelihood of its acquiring an equity control of some suitable productive capacity already in existence. The adoption of such a scheme, he said, would in all probability make it necessary for an increase of the capital by the introduction of a security junior to the existing preference shares. Immediately the directors had reached a decision in the matter, an extraordinary meeting would be called.

THE TRUSTEE FOR THE HOLDERS of the seven per cent. sterling bonds of "Cosach," the Chilean nitrate combine, announces that for the last eight months of 1932 the monthly payments provided for under the trust deed for placing the trustee in funds for the payment of interest and sinking fund instalments on the bonds have not been received. The total funds now in the trustee's hands are but little in excess of the sum required for paying the interest coupon on the bonds falling due on December 31, so that upon payment of that coupon, in accordance with the notice for payment now issued by J. Henry Schroder and Co., and failing the receipt of the interval by the trustee of further remittances, the funds in the trustee's hands will be practically exhausted.

Obituary

MR. WALTER W. DUFFIELD, Fellow of the Chemical Society, for over fifty years gas analyst to the City of London, on December 23, at Braintree, Essex, in his 80th year.

The Year's Market Conditions

Reviews from Manchester and Glasgow

BUSINESS in chemicals in the Manchester district during the past year has been largely under the influence of conditions in Lancashire generally, especially in the cotton textile industry. How the cotton trade has fared throughout the year is too well-known to require undue emphasis here. It needs only to be said that the consumption of many lines of bread-and-butter chemicals in the textile allied industries of bleaching, dyeing and finishing has been substantially below the normal aggregate quantity. During the last three months of the year, and more especially since the settlement of the disputes in both the spinning and weaving sections of the cotton trade, with the reductions in manufacturing costs as a result of the lowering of wages, prospects have improved to some extent, with a consequent slight expansion in the movement of chemicals. In most other branches of the consuming industries in Lancashire, outlets for chemical products have been on a relatively small scale, although rarely has the contraction been so serious as it has been in the textile trade.

Prices of heavy chemicals on this market have been remarkably steady during the twelve months when regard is had to the uncertain conditions in most other branches of trade, and to the tariff developments in this country. The majority of the potash compounds are dearer than they were a year ago, and there have been advances also in other lines of imported materials. On balance, however, there has been little change in the price position of soda and ammonia products, and only relatively narrow fluctuations have occurred in respect of most other descriptions. Exceptionally, the lead and copper compounds have moved rather widely in sympathy with the non-ferrous metals and the year-end prices of these products are lower than they were twelve months ago.

In the earlier part of this year, business in the Scottish heavy chemical market was fairly steady, although the margin of profit was exceedingly small, and quantity buying was not looked upon with favour by buyers. During March the Government sought a sequel to the financial position by the imposition of tariffs as some counter action to the results of the fall in the gold standard, and while it is somewhat difficult to say at this stage whether or not the net result will prove satisfactory to the British chemical manufacturer, the manufacturer and incidentally unemployment has benefited considerably.

Taking the full year 1932, there has been a steady increase in business generally, and while home price conditions show a tendency to rise this will react to the benefit of employer and employee alike. The Scottish chemical market is now in a much better position than that of a number of years back.

Forthcoming Events

Jan. 2.—Institution of Chemical Engineers. Joint meeting with the London Section of the Society of Chemical Industry. "The Patents and Designs Act, 1932, and Chemical Industry." C. Hollins. 8 p.m. Burlington House, London.

Jan. 3.—Business Research and Management Association of Great Britain. "Efficient Marketing Through Sales and Advertising Planning." H. G. Mitchell. 6.45 p.m. Anderton's Hotel, Fleet Street, London.

Jan. 4.—Institution of the Rubber Industry (West of England Section). "Estate Practice and its Relation to Factory Requirements." F. B. Jones. Town Hall, Trowbridge.

Jan. 6.—Society of Chemical Industry (Food Group and Manchester Section). "The Conservation of Vitamins in Food Manufacture." Professor J. C. Drummond. "The Need for Standardisation of Products containing Added Vitamins." Dr. S. W. F. Underhill and Miss K. Culhane. 7 p.m. 17 Albert Square, Manchester.

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Clerk to the Board.

Town Hall,
Dewsbury.
December, 1932.

PUBLIC NOTICE

PATENTS AND DESIGNS ACTS, 1907 to 1932.
NOTICE is hereby given that Boot's Pure Drug Co., Ltd., Frank Lee Pyman and Alexander Peter Tawse Easson, all of the Company's Works, Station Street, Nottingham, seek leave to amend the Specification of the Application for Letters Patent No. 381,362, for an invention entitled "Improvements relating to the production of organic salts of bismuth."

Particulars of the proposed amendment were set forth in No. 2292 of the Official Journal (Patents), published on December 21st, 1932.

Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25 Southampton Buildings, London, W.C.2, within one calendar month from the date of publication of the said Journal.

M. F. LINDLEY,
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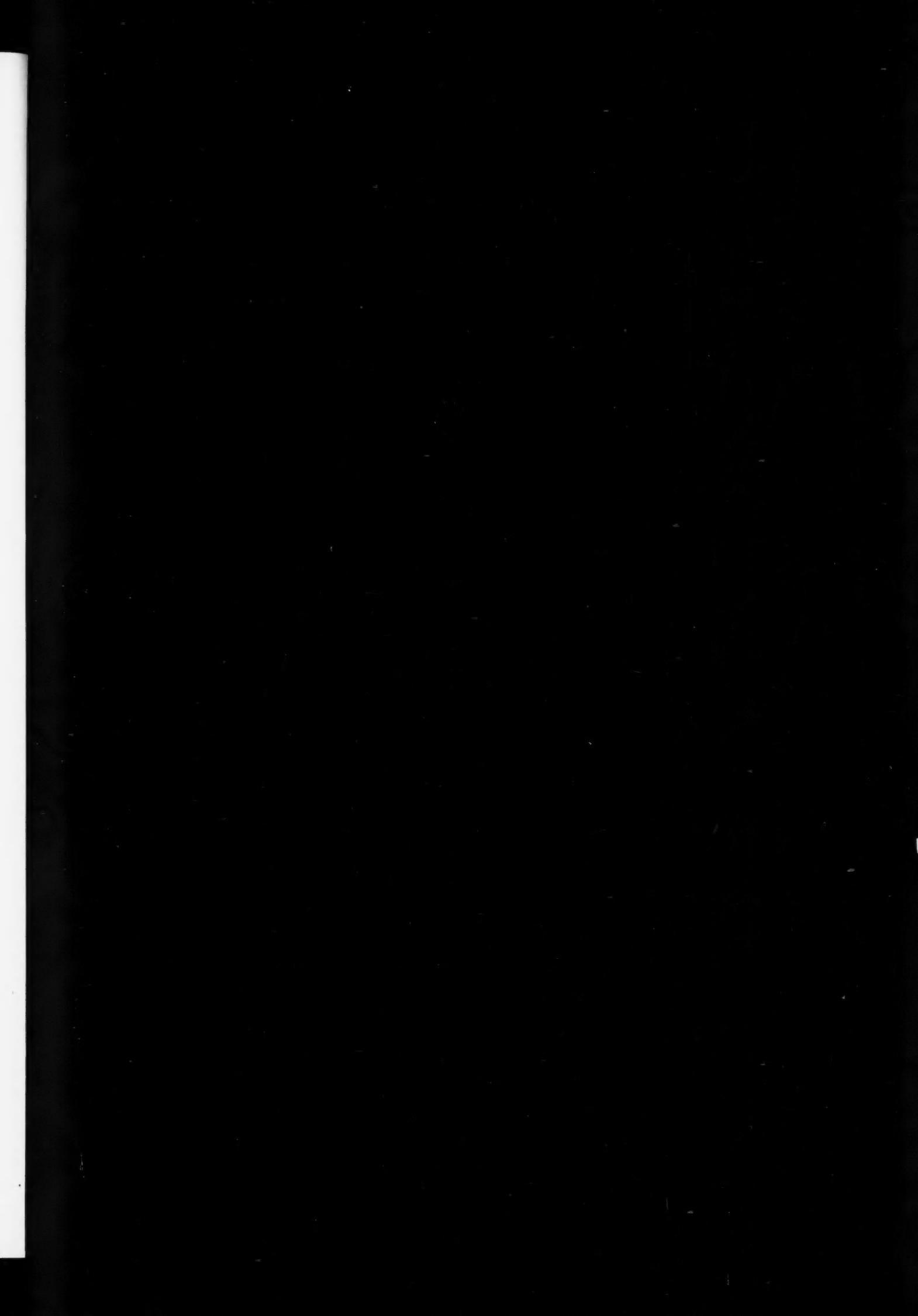
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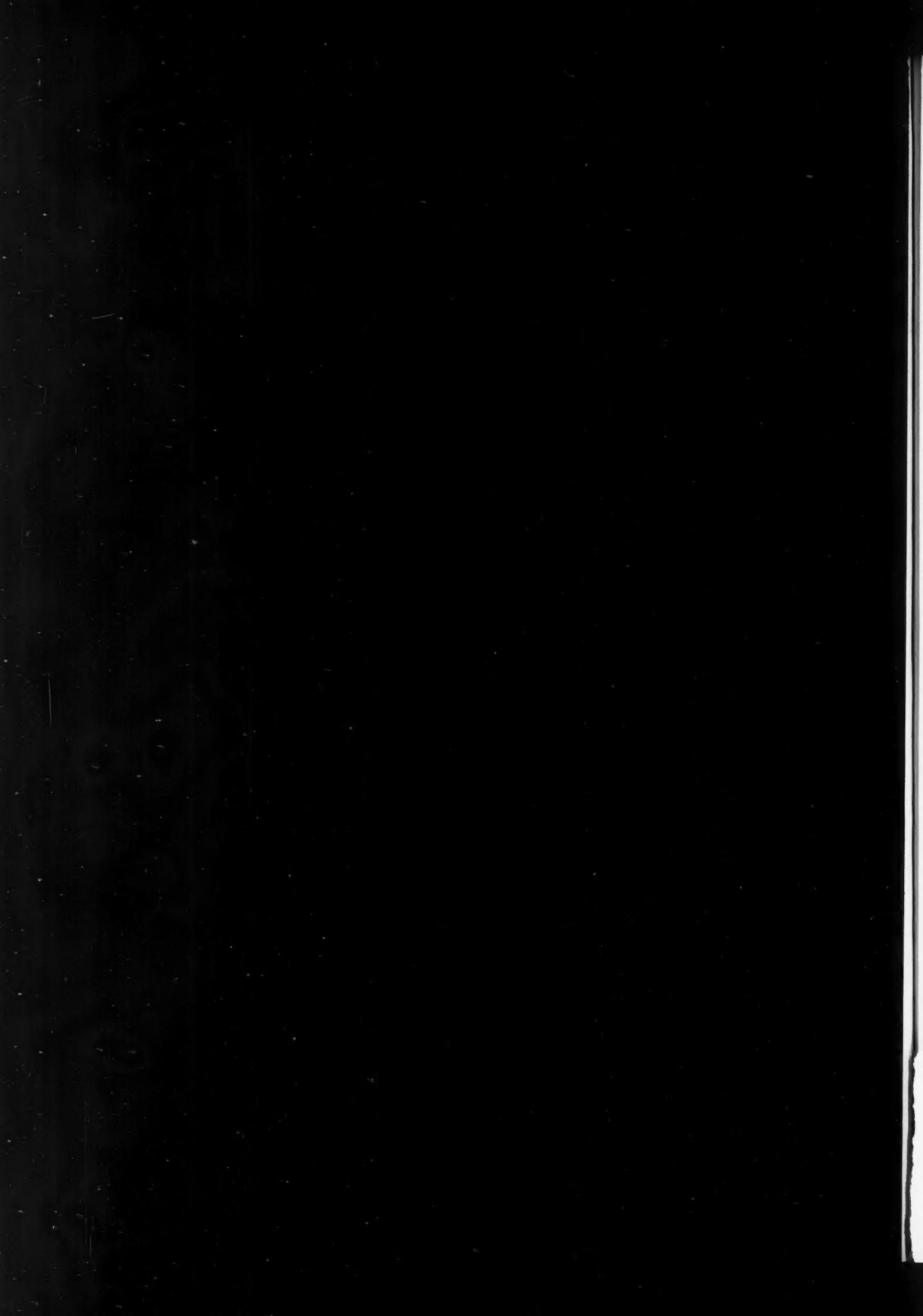
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PATENTS obtained, trade marks and designs registered, at home and abroad.—GEE AND CO. (Patent and Trade Mark advisers to THE CHEMICAL AGE), 51-52 Chancery Lane, London, W.C.2. Telephone: Holborn 1525. Established 1905.

THE Proprietor of British Patent No. 280,039, dated November 16, 1926, relating to "IMPROVEMENTS IN APPARATUS FOR THE REFINING OR CRACKING OF HYDROCARBONS," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. Inquiries to B. Singer, Steger Building, Chicago, Illinois.

THE Owners of Patent No. 284,280 are desirous of arranging by way of licence on reasonable terms for the commercial development in Great Britain of this invention, which relates to a process for sulphonation of oils.—For particulars address H. DOUGLAS ELKINGTON, Chartered Patent Agent, 20-23 Holborn, London, E.C.1.





Metallurgical Section

July 2, 1932.

Current Topics

Volume Changes in Cast Iron

THE United States Bureau of Standards, in co-operation with the American Foundrymen's Association, recently made a study of methods for determining volume changes in metals during casting. A knowledge of the magnitude of these volume changes is considered essential to good foundry practice in order to produce sound castings economically. A method was developed, applicable to cast irons as well as to non-ferrous metals, which permits determination of the shrinkage undergone by the metal from a temperature in the liquid state to room temperature. The application of this method under actual foundry conditions, however, is too involved and time-consuming. Consequently, an indirect method, based upon data obtained on twelve cast irons, was devised by means of which it is believed the volume changes occurring in iron during casting can be quickly determined in the foundry and with sufficient accuracy for all practical purposes. The total amount of impurities and the linear contraction of the cast iron in cooling from the freezing temperature to room temperature are all that need be determined in the foundry. The volume changes that take place while cooling in the liquid state, during solidification, and upon cooling to room temperature are then calculated from this data and from charts described in a recent Bureau publication.

Properties of Cast Brass

IN 1929 when the special committee of the American Society for Testing Materials for promoting the general use of specifications for copper alloys in ingot form made a survey of the industrial field, it was found the 600 copper-base alloys then in use might be grouped into 20 classes. Simplification in industry inspired the hope that eventually each class might be represented by one composition. The Non-Ferrous Ingots Institute therefore agreed to sponsor an investigation at the Bureau of Standards under the research associate plan. The purpose of this investigation was to obtain data upon which to base further work of bringing about agreement upon an optimum number of typical compositions of copper-base ingot metal and to develop equitable standard specifications for the different classes. The advisory committee of the Institute suggested that as brass of the nominal composition of 85 per cent. copper and 5 per cent. each of zinc, tin and lead, is one of the most widely used copper-base alloys, it should be the first alloy investigated. The effect of pouring temperature and the influence of the use of virgin metal of remelted metal were other factors to be studied.

Tensile strength, Brinell hardness, electrical resistivity and density were determined for various types of test bars cast at temperatures ranging from 1,900 to 2,300° F. The maximum values were obtained for the test bars cut from the chill ingot, and pouring temperature had little influence on these results. Somewhat lower values were obtained for the test bar produced by the immersion in the molten metal of a graphite shell. Still lower values were obtained for the sand-cast test bars, where it was found that a pouring temperature above 2,200° F. had a pronounced influence on physical properties. A study of the metallographic structure of the test bars poured at high temperature indicated that the marked columnar structure formed under such conditions is accompanied by inferior physical properties. Microscopical examination of the same bars showed markings due to strain or deformation in the sand-cast bars that were absent in the bar from the immersion crucible. To this was attributed the difference in physical properties at the high temperatures. The alloy made from remelted metal was found to be somewhat more fluid than from virgin metal cast under the same conditions. When the shrinkage of the alloy from the highest pouring temperature to room temperature was determined, it was noted that the alloy expands slightly immediately after solidification after which it contracts at a uniform rate to room temperature.

Nickel-Clad Steel Sheets

THE interest aroused by the advent of nickel-clad steel sheets and the rapid realisation of their potential uses, have created a demand for the composite plates in a wide range of size and gauge. Plates up to 27ft. 6in. x 8ft. are now being made, and the production of larger sizes is projected. The material can be obtained with a surface finish of nickel oxide (obtained by rolling at high temperatures) or with a bright finish superior to that obtained by standard plate-mill practice. The intimacy of the bond between the nickel and the steel enables the composite sheet to be worked by the methods usually employed for steel plate, and ensures an uninterrupted flow of heat by surface transference, a feature of importance in certain forms of equipment. It must be observed, however, that only a continuous nickel surface should be exposed to a corroding medium, for simultaneous exposure of the nickel and the steel gives rise to galvanic corrosion; that solid nickel rivets or rivets protected by nickel should be used, and that in hot-working, suitable precautions must be taken to prevent sulphur attack. Mechanical properties for plate made from 0.2 per cent. carbon steel clad with 10 per cent. of malleable nickel

were given by E. G. Hill, in a paper dealing with nickel-clad steel plate for equipment, in a recent issue of "Chemical and Metallurgical Engineering."

Nickel Alloy Steel Castings

A RECENT contribution to the literature of steel castings, in the form of a publication of the International Nickel Co., enumerates briefly the more important effects obtained by the addition of nickel, chromium, manganese, molybdenum and vanadium, singly or in combination, and summarises the foundry processes involved in making additions of these elements. It is emphasised that the production of satisfactory castings requires unremitting attention at every stage of manufacture and that in order to ensure material of reliable and regular properties, carefully controlled heat-treatment is necessary. Recommended practice for annealing, homogenising, normalising, quenching and tempering operations is outlined, and

certain fundamental points relative to correct design are discussed. The remainder of the paper deals specifically with the composition, treatment, properties and applications of nickel alloy steel castings for use under conditions demanding high impact and fatigue strength, high strength and appreciable toughness, resistance to abrasion, heat and corrosion-resistance. The compositions dealt with contain nickel alone, or in conjunction with chromium, molybdenum, vanadium and manganese. Notes are added on the use of nickel steel castings in certain special fields, such as nickel-chromium steel (nickel 1.75—2.25, chromium 0.7—0.9 per cent.), for high temperature fittings in power plants and oil refineries, and nickel-chromium (nickel 2.75—3.5, chromium 0.8—1.0 per cent.) for track work. The data presented amply demonstrates the fact that nickel alloy steel castings, on account of their tensile and impact and fatigue strength, constitute engineering materials which offer very high factors of safety.

Expansion of the Platinum Trade of Germany

Exports of Metal and Manufactures

GERMANY is dependent upon foreign sources for the platinum required by its industries, and is one of the leading consumers of this metal, ranking second in importance, after the United States. Before the world war, according to an article which appears in "Commerce Reports," there was an important German industry for smelting platinum ores of Russian origin, with two important platinum smelters in Hanau belonging to W. C. Heraeus, G.m.b.H. and to G. Siebert. The latter was established in 1885 as a private firm; in 1905 it was affiliated with the powerful Deutsche Gold und Silver Scheideanstalt of Frankfort-on-the-Main, which converted it, in 1921, into a G.m.b.H., or limited liability company. Before the war the Heraeus company was connected by special contracts with Compagnie Industrielle du Platine of Paris, then controlling about eight-tenths of the platinum production of Russia, which was producing nine-tenths of the entire world output. Since the war important changes have developed. When the Soviet Government assumed control of the Russian platinum mines and took over the distribution of platinum ore, Germany ceased to be an importer of platinum ore. It now imports only the raw metal, which it further refines and works into sheets and wires for jewellery, and into utensils and apparatus for chemical and electro-technical activities.

Apparent Change in Source of Supplies

Despite the loss of the smelting operations, the platinum industry in Hanau, where it is concentrated, has expanded greatly in recent years, owing largely to increase in the foreign trade. In 1913 only 140 workers were employed; in 1927, 200; in 1928, over 300. In recent years a third supplier has entered the German trade—Edelmetalle Vertriebsgesellschaft (Rusplatin), representative of the Russian production in Germany. Imports of platinum metal (including iridium, osmium, palladium, rhodium, ruthenium, alloys, and scrap), after decreasing from 3,919 kilos in 1929 to 3,407 in 1930, showed a marked recovery in 1931, when they amounted to 3,098 kilos during the first 10 months, compared with 2,385 kilos imported in the first 10 months of 1930. Russia was by far the leading source of these imports in 1930, it supplied 1,427 kilos, followed by 735 from Luxembourg, 437 from Great Britain, 324 from the United States, and 161 from Norway. In the first 10 months of 1931 Czechoslovakia appeared as the leading supplier with 1,987 kilos, followed by 318 from Great Britain, 316 from the United States, and 315 from Russia. This alteration in recorded sources is probably due to transhipments. In recent months the bulk of the output of Russia, Canada, South Africa, and Colombia has been handled by Consolidated Platinums, an English company organised by agreement of the chief producers of the four countries.

More than half of Germany's imports of platinum metal are re-exported. During the first 10 months of 1931 these

exports showed a pronounced increase to 2,551 kilos, compared with 1,454 in the corresponding period of 1930, 1,828 in the entire year 1930, and 2,747 in 1919. In the first 10 months of 1931 exports of platinum amounted to more than five-sixths of the quantity of the imports and represented almost double the import value. Exports of platinum wares greatly exceed imports under this class, as the German platinum working industry is of outstanding importance. Exports of manufactures, in contrast to metal, however, declined markedly from 9,739 kilos in 1929 to 3,069 in 1930 and only 496 in the first 10 months of 1931. In 1930 Germany imported platinum wares to the amount of 98 kilos, while such imports totalled only 40 kilos in the first 10 months of 1931.

Properties of Nickel Alloy Steels

Effect of Cold-Work Prior to Heat Treatment

THE influence of cold-work carried out before heat-treatment, as affecting mechanical strength and yield point, has been studied in two series of tests which are reported by E. Greulich in the "Archiv für des Eisenhüttenwesen."

These tests cover certain types of structural and of high-alloy corrosion-resisting steels. In the first series, four carbon steels, a 5 per cent. nickel steel, a 14 per cent. chromium steel and a 35/10 nickel-chromium steel, heat-treated to remove stresses due to hot-rolling, were subjected to successive reductions of 25 per cent. by cold-rolling, and were then annealed for three hours; comparison was made of the tensile properties of the specimens so treated with those of samples of the same steels annealed from the "as received" condition without immediate cold work. In the case of the two nickel-containing steels, heat-treatment (at 610°-620° and at 900° C., respectively) produced no appreciable change in the mechanical properties, either with or without preliminary cold working. Microscopical examination showed that the pearlite of these steels in the hot-rolled condition was already in the granular form.

The second part of the investigation deals with the study of age-hardening in two steels containing, respectively, carbon 0.41, nickel 36.05, chromium 9.60, per cent., and carbon 0.51, nickel 33.05, chromium 10.71, per cent. The steels, after heating at 1,200° C. and water-quenching, were cold-rolled to reductions varying up to 45 per cent., the specimens were subsequently tempered, for various periods, at 650°-700° C. before testing. The increase in yield point and mechanical strength obtainable by precipitation-hardening are enhanced by slight cold-working, and can be obtained after a shorter period of heating and over a wider range of temperature than by heat-treatment not preceded by cold-working. Over 10 per cent. cold-work, however, causes progressive loss of improvement in properties.

The Separation and Recovery of Copper and Nickel

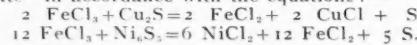
How the Problem has been Solved in a German Works

AN informative article on the recovery of copper and nickel from materials containing these metals, which, with suitable modification, might find profitable application to the treatment of British resources of similar material, appears in a recent issue of "Metallbörse." The author, Dr. Walter Savelberg, declares that an effective separation of copper and nickel by electrolysis in a single cycle has up to the present only been attained by one process, namely, that worked out for the Allgemeinen Elektro-Metallurgischen G.m.b.H., which, but for a short interruption during the war and post-war years, has now been in operation for the past thirty years.

The copper-nickel materials, which comprise ores, residues, and smelter-products, are first prepared for leaching. They are smelted for a "raw-matte" product which is ground, sinter-roasted and smelted for a "concentration-matte," and this is then blown in a small converter to "fine-matte" (corresponding to "white-mat" in copper-smelting). This material is ground to fine dust and now passes to the leaching plant, which comprises 12 agitating machines lined with acid-resisting material and furnished with gas-tight covers. The powdered material is here stirred with liquor which is a by-product of the nickel-electrolysis section and carries about 15 grams of nickel per litre. With it is admixed a Fe(OH)_3 and CuS -bearing slurry (a by-product from another part of the process) and also hydrochloric acid. First, ferric chloride is produced, by the reaction:—

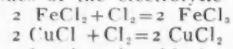


This is an effective leaching agent and acts upon the "fine-matte" in accordance with the equations:—



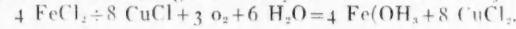
The Use of Chlorine

The ferrous and cuprous chlorides resulting from these reactions are next oxidised ("chlorinated") to the ferric and cupric states respectively by means of chlorine which is a by-product of still another part of the process, being produced at the anodes of the electrolytic baths:—



In order that the chlorine may be most effectively absorbed it is pumped through the series of agitators in countercurrent to the flow of the liquors, entering at the last agitator from which the liquor, together with a sludge which carries still undissolved matte, discharges into a large stirrer of about 25 cu. m. capacity. Here the oxidised chlorides again become reduced to the lower form.

There are two of these large stirrers in operation, working alternately. In one, the liquors are directly steam-heated and at the same time subjected to the action of air-jets, whilst the other serves for providing fresh supplies of electrolyte for the tanks. The heating of the liquors which carry fairly high contents of FeCl_3 , CuCl_2 and NiCl_2 stimulates the reactions given above, so that a further dissolution of the "fine-matte" sulphides proceeds, whilst, at the same time, precipitation of iron is brought about by the action of the airjets:—



The Electrolytic Plant

By this cycle of reactions the copper content of the fine-matte is completely converted to cupric chloride and the nickel also to its respective chloride, the solutions, after separation from the accompanying slimes by filtration, being ready for treatment at the electrolytic section of the works, either directly in depositing tanks or at the preliminary purifying section. The slime, which carries active ferric hydroxide and also some copper sulphide (resulting from an interaction between nickel sulphide and copper chlorides) in part is used over again for incorporation with the leaching reagents. In it also a greater part of the separated sulphur accumulates, whilst any precious metal in the original materials also collect and can be readily recovered.

The electrolytic plant consists of 50 baths, of which ten serve for the separation of copper and the remainder for nickel recovery. They are rectangular cement tanks with acid-

resistant linings, 3.50 m. long, 1.80 m. wide and 0.70 m. deep. Each tank carries eleven rows of 16 anodes made of Acheson graphite, the upper portions of which are fitted with hollowed gas-tight cement caps whilst the lower portions project into a diaphragm. The cement caps are connected to an off-take pipe through which the liberated chlorine is withdrawn and becomes available for the leaching operations. Between the anode cells are suspended ten rows of cathode sheets, the copper baths having three to six copper sheets and the nickel baths six to twelve nickel sheets. The baths are all connected one behind the other and through them passes a total current of 2,000 amps. at 200 volts. The terminal-voltage for each copper bath is 2.1 to 2.3 volts; for the nickel baths, 3.1 to 3.3 volts. The electrolyte flows, evenly divided, through two adjacent parallel rows of baths; the copper electrolyte entering with a content of some 30 grams Cu per litre whilst it leaves with 8 grams of copper per litre, this having been found to yield a coherent deposit of copper free from nickel.

Recovery of Copper

The liquors then leaving the copper-electrolysis section are next treated by the usual cementation processes for the recovery of the residual copper, but the precipitated "cement" copper, being somewhat impure, passes back into the process. A daily yield of about 900 kilos of copper is obtained at the plant reckoned on an efficiency of 80 per cent., and a deposition of 2.35 grams of metal per amp.-hour from the chloride solution. The de-coppered liquors pass on to the solution-purification plant. Here they are first oxidised by a chlorination process using more of the by-product chlorine; iron is separated by means of CaCO_3 in a stirrer-machine, whilst the last traces of copper and other impurities are removed by means of H_2S . Finally, in a third stirrer the cobalt is separated by the addition of bleaching powder and milk of lime, whereby considerable amounts of nickel also come down.

The searching purification of the liquors is a very essential preliminary to the nickel electrolysis, owing to the marked tendency of the other constituents present to be deposited with the nickel under the electro-chemical conditions required, even when only small proportions of impurity are present. For these reasons also the acidity of the solutions has to be kept very low ($\text{pH} = 3.5$); with higher acid concentrations there tends to develop an evolution of hydrogen accompanying the nickel deposition, owing to which not only does the current efficiency decrease but the quality of the nickel deposit is also at the same time affected. It has been found useful in practice to have present a small proportion of a weak organic acid which in the course of the electrolysis is slowly decomposed and continuously replenishes the otherwise diminishing amount of H -ions. Efficiency in the nickel baths amounts to upwards of 95 per cent., and the capacity of the plant is about 2 tons per day. The resulting nickel is very pure, assaying 99.80 per cent. of nickel, with a maximum 2 per cent. of cobalt.

Lead in the United States

Statistics for 1931

THE output of refined primary lead in the United States, from domestic ore, in 1931, amounted to 390,260 short tons, valued at \$28,870,000 (approximately £6,000,000), compared with 573,740 tons, valued at \$57,374,000 (approximately £11,800,000), in 1930, a decrease of 32 per cent. in quantity and of 50 per cent. in value. The production of refined lead from foreign ore, principally from Newfoundland, Mexico, and Canada, amounted to 52,504 short tons—a decrease of 24 per cent. from the production in 1930. Consequently, there was a decrease in the total output of primary lead from domestic and foreign sources of 31 per cent. The quantity of refined primary lead available for consumption in the United States in 1931 amounted to about 411,000 short tons, as compared with about 583,000 tons in 1930, a decline of 30 per cent.

British Cast Iron Research Association

New Laboratories at Birmingham

LORD RUTHERFORD, professor of experimental physics and director of the Cavendish Laboratory at Cambridge University, is to open the newly extended laboratories of the British Cast Iron Research Association at St. Paul's Square, Birmingham, on July 6, when the opening ceremony will follow a luncheon at which Sir Harold Hartley, president of the Association, will preside. The extensions to be opened cover a space of some 4,500 sq. ft. and accommodation is provided for a library and office, a melting shop, and research, mechanical, testing, microscopic, chemical and development laboratories.

The British Cast Iron Research Association was established in 1921, Birmingham being chosen as the headquarters, as the main centre of the trade. The original offices were in New Street, and in 1924, when Mr. J. G. Pearce, a graduate of Birmingham University, returned to the city to take up the post of director and secretary to the Association, a laboratory for research work was hired not far from the city centre. Two years later a move was made to the present premises in St. Paul's Square, and since those days the record of the Association has been one of steady progress and much useful work on behalf of the industry. Recently, however, there has been a reduction of £2,000 in the grant allowed by the Government, and it has become highly desirable, if the Association, which is mainly supported by the trade itself, is to continue its valuable service, that it should increase its membership and secure wider support.

The work which the Association is doing relates to the founding industry. It is the constant endeavour of the Association to improve the quality of cast iron and to assist in securing its more economical production, by investigation into the whole of the materials going into the foundry process, by an investigation of cast-iron itself, and the examination of moulding sands in which the models are cast and of the furnaces in which they are moulded. In the laboratories the work is devoted to chemical analysis, microscopic examination and mechanical and physical testing, each section being in charge of an expert. It is computed that on sands, and on the melting and moulding furnaces alone, if the industry throughout the country were to adopt the Association's recommendations, £250,000 a year would be saved.

The Association's services to its 350 members may be grouped broadly under three main headings. Firstly, it provides the finest library in the world on founding. All the foreign contributions to the subject are collected, systematically stored and, if necessary, translated for the benefit of members. If anyone in the country, or the world for that matter, seeks specialised information in connection with the industry, this is the place to which the query almost invariably goes and where the necessary information is almost invariably forthcoming. The Association also carries out investigations which are circulated in the form of periodical reports, over one hundred of which have so far been issued. Thirdly, it is engaged in providing for the useful application of the results which are obtained in the laboratories.

Bismuth in Industry

New Uses Anticipated

THE United States Bureau of Standards has recently been engaged in research with the view of extending the uses of bismuth, endeavouring not so much to substitute it for other metals now in use but seeking to utilise the unique properties of the metal itself. In the course of this work bismuth wire, in lengths of 20 feet, has been produced successfully for the first time by extrusion.

Bismuth alloys have been used for making delicate castings, such as dental dies from plaster impressions; to hold delicate castings or pieces of irregular shape during machining or testing operations; and to furnish gas-tight liquid seals for apparatus, such as nitriding ovens. Bismuth amalgams, with or without lead and tin, have been used for the production of mirrors with a lustre reported to be equal to that of silver. Added to tin bismuth will impart hardness, sonorousness, lustre and fusability. A 10 per cent. addition of bismuth improves the appearance of a tinned joint on hot or cold rolled steel. An alloy for hardening bearing metals contains antimony 70 parts by weight, tin 25, copper 3 and bismuth 2. Bismuth alloys, such as those with lead, whether high or low in bismuth, have good casting qualities and produce good impressions of the mould. For this reason, pure bismuth or Bimich alloys have been used in making patterns, and smaller amounts of bismuth (up to 15 or 20 per cent.) have been used in stereotype and similar metals. The pure metal and the very rich alloys expand on solidification, but the alloys of lower bismuth content contract. They produce sharply defined castings in spite of this contraction because the presence of bismuth, or of antimony, in the case of lead-antimony alloys, lowers the surface tension and the viscosity of the molten mixture, so that, while still liquid, it follows the contours of the mould.

Increasing the Workability of Copper

In amounts up to about 1 per cent. bismuth has been added to various brasses and bronzes and to anti-friction metals, but smaller amounts of bismuth, or when it is present as an impurity, are usually regarded with extreme suspicion. Small amounts present in copper or gold make them unworkable, and the presence of bismuth in lead which is intended for the manufacture of white lead is objectionable.

Bismuth wire, prepared either by extrusion at elevated temperatures, or by melting and drawing within glass tubes, has been used in thermocouples, pyrometers, galvanometer suspensions, hair lines for microscopes, etc. The high thermal e.m.f. of bismuth can be used to produce a very sensitive thermocouple, but the wire is brittle and difficult to handle. If the wire is prepared by drawing down a glass tube filled with metal, the glass may be removed with hydrofluoric acid or left for insulation and protection. The electrical and thermal conductivities of bismuth are extraordinarily low and the electrical conductivity further decreases when exposed to the influence of a magnetic field. Consequently, bismuth has been used in the construction of instruments for determining the strength of magnetic fields. It has been reported that bismuth up to 2 per cent., like silicon, increases the electrical resistance of steel without diminution of the magnetic permeability or dissipation of energy through hysteresis. Bismuth steels have been suggested as a substitute for silicon steels for transformer sheet. From a study of the iron-bismuth diagram it is difficult to understand how bismuth steels can be made.

World Production

The world output of bismuth is from 400 to 500 tons annually. The available statistics of several countries are either lacking or presented in terms of ore or concentrates for which the percentage content is not given but the average probably lies within the figures stated. Roughly one-half the total is derived from Bolivian ore, most of which is refined in England. The United States, Germany and Spain are the other principal sources of supply, probably about in the order named. Australia, formerly a major producer, has gradually become of minor importance. Peru is an occasional contributor and is a prospective source of by-product production on a considerable scale. Practically all the bismuth produced in the United States has been obtained from the treatment of slimes resulting from the refining of lead bullion by the Betts electrolytic process. For a few years bismuth was recovered from electrolytic tin refinery slimes, but the last of these plants ceased operations in 1924.

The Manufacture of Alloy Cast Iron

Ensuring a High Degree of Uniformity

THE production of alloy cast irons in the foundry by the direct use of refined alloy pig irons deserves attention from several points of view. Probably the most important is the fact that the use of such irons offers the only way of ensuring the strictest uniformity in composition of the final alloy product. It cannot be disputed that the highest degree of uniformity can be maintained best by the use of such alloy pig irons in which the initial alloy content is guaranteed both as to uniformity of distribution and quantity. It is commonly suggested that additions of such alloys as nickel, chromium, manganese, vanadium, titanium, molybdenum and others can be made either by addition of the metal or rich alloys of the metal to the mixture in the cupola or to the molten metal issuing from the cupola spout into the ladle. When the extended use of such alloy additions is desired, these methods are generally unsatisfactory, and leave much to be desired. Ladle additions of any metal or alloy whose melting point is not considerably below that of cast iron are open to the difficulty of getting the metal or alloy thoroughly dissolved and incorporated in the molten cast iron. This is true even although the materials are added in finely divided form, such as shot or thin foil or sheet.

Effect of the Addition of Chromium

Chromium has a powerful effect in stabilising the combined carbon and preserving free carbides in cast iron. In view of this powerful effect, it will be evident that careful and exact control of the quantities used is necessary and small variations are liable to be accompanied by violent changes in hardness and machineability. The ferro-chromium alloys are the most common source of chromium for alloying purposes, and these alloys, apart from their chromium content, are distinguished by the amount of their carbon content. Such alloys are available from the "carbon free" varieties up to those containing 8 per cent. to 10 per cent. carbon. The melting point of pure chromium itself is high, *viz.*, 1,620° C. as compared with eutectic iron carbon alloy of 1,150° C. The ferro-chromium alloys are likewise very refractory and in the high chromium alloys containing from 6 per cent. to 8 per cent. carbon there exist compounds which only melt completely above temperatures of 1,600 to 1,700° C. These considerations entirely rule out the possibility of successfully adding chromium as a ladle addition. The use of rich ferro-chromes in the cupola mixture has been tried and the results prove to be generally unsatisfactory. Even in the cupola there is considerable difficulty in ensuring the complete melting of the ferro-chromium alloys apart from the potentially high losses due to oxidation, and it is remarkable how the refractory carbon chromium compounds can persist unmelted and undissolved in molten cast iron. A further difficulty is often experienced with alloy additions made in this manner, particularly in those cases where the metal is tapped out of the cupola in small quantities. This difficulty is that of irregular distribution of the alloy. In the case of those alloys whose influence on the character of the carbon is very pronounced, this difficulty is a serious one.

Refined Chromium Pig Iron

The most satisfactory method of making alloy additions to cast iron is by the use of alloy pig irons containing the requisite quantity of the alloy or alloys conjointly with the required amounts of other constituents, carbon, silicon, manganese, sulphur and phosphorus. Where close accuracy in the amount of alloy present in the final mixture is required, it is preferable to use a pig iron as close as possible in composition to the finished requirements. This is emphasised in a brochure which has recently been issued by Bradley and Foster, Ltd., of Darlaston, Staffs., who manufacture refined alloy pig irons to meet the specifications of individual users.

In Bradley's refined alloy pig irons, the alloys are incorporated with genuine refined irons during their manufacture in the refineries. To ensure the maximum properties, freedom from slag and dissolved gases, thorough admixture of the alloys, these alloy pig irons are treated by a patented

de-gasification process, by which the conservation of those inherent and intrinsic properties of genuine refined irons is ensured. They are supplied either in the form of sand cast or machine cast pigs, a special form of machine cast pig having been designed to enable greater accuracy of control in making up mixtures.

For general purposes, and in view of the need for a straight refined chromium iron to be used direct for the manufacture of chromium iron castings, four standard refined chromium irons to the undermentioned limits of chemical composition are now manufactured. In order that these irons shall be of the widest possible value for general work, the general composition has been designed on the basis of the British Standards Institution Specification for Aircraft Material 2K11 and 4K6—CA8 and 9 for 4K6—CA10 and 11 for 2K11. Castings made from these irons have a generally higher Brinell hardness and in sections up to $\frac{1}{2}$ in. are suitable for hardening and tempering. The irons can be used direct without any admixture, and under good conditions of melting will carry up to 20 per cent. of returned scrap. For mixing purposes, three refined chromium irons are available. Grades CD and CE contain from 2 per cent. to 3 per cent. chromium, and the amounts of silicon and phosphorus can be supplied to suit requirements. Obviously, these constituents must be adjusted with due regard for the components of the mixture.

The Lowest Melting Point

Grade CF alloy has a composition approximately that of the invariant point or ternary eutectic of the chromium iron carbon alloys, and as such, has the lowest melting point of this series of alloys. In accordance with von Végesack's determinations this composition is 8.0 per cent. chromium, 3.6 per cent. carbon, and 88.4 per cent. Fe., with a melting point of 1,050° C., and a freezing point of 1,090° C. These temperatures are modified somewhat by the presence of silicon, manganese and phosphorus, but by reason of their low melting temperatures this pig iron is recommended for chromium additions.

The Bradley standard refined nickel pig irons have a general composition based upon the B.S.I. specifications for Aircraft Material 2K11 and 4K6. This basis has been chosen as being of the greatest service for general requirements. These irons can be used direct without any admixture and under good conditions of melting will carry up to 20 per cent. of returned scrap. Standard refined nickel chromium alloy pig irons have also been built up from the B.S.I. Specifications for Aircraft Material. Here the nickel contents have been carefully designed to combine the maximum degree of utility with the minimum of expense. These irons are suitable for use alone for the direct production of castings, and up to 20 per cent. of returned scrap can be used. In melting under good conditions of cupola practice, the loss in nickel is negligible, and the silicon and chromium losses should not exceed 10 per cent. in each case. Such irons can be used for the production of castings suitable for oil hardening and tempering in sections up to one inch thick, but for greater thicknesses, in order to ensure uniform hardening throughout the section, higher nickel contents should be used.

Aluminium Die-Casting Alloys

Results of Tests

DATA accumulated by the American Society for Testing Materials as the result of examination of twelve aluminium-base die-casting alloys, submitted by five producers, has been correlated, and the relative serviceability of the alloys evaluated. The report of this work appears in the "Proceedings" of the Society, Vol. 31, (1) 268-277. The data made available include results of impact, tensile and elongation tests made by six co-operating laboratories. A number of the alloys contain nickel, varying in amount up to 5 per cent.

Some Inventions of the Month

Thermo-Aluminic Processes

A METHOD of accelerating the reaction in thermo-aluminic processes, particularly for welding, according to Specification No. 367,361, of Goldschmidt A.-G., Essen, Germany, consists in adding to or alloying with the aluminium of a normally constituted mixture a small amount of one or more elements such as calcium, sodium and magnesium, which possess a greater affinity for oxygen than is the case with aluminium.

Desulphurising Pig Iron

IN a process for producing desulphurised pig iron, as described in Specification No. 367,602, of H. Steinebach, Dillnhütten, near Geisweid, Germany, iron ore is subjected to a cold blast process in a blast furnace without employing desulphurising agents and the molten iron, which must contain at least 1 per cent. of manganese, is tapped off into a separate container in which it is cooled, the manganese in the iron combining with the sulphur to form manganese sulphide. The iron is then cast into pigs.

Improving the Composition of Slag

SPECIFICATION No. 368,312, of L. P. Basset, Paris, deals with a process for producing simultaneously iron and Portland cement or hydraulic lime, sufficient lime and if necessary other ingredients, such as silica or alumina, being added to the ore to give the slag the desired composition. The charge is ground to a fine powder and introduced into a rotary furnace which is heated by the combustion of pulverised fuel with the proportion of air required to obtain a carbon monoxide content of the furnace gases sufficient to prevent re-oxidation of the metal and without fusion of the charge. The products leaving the furnace are cooled in a cooler, crushed and the iron, etc., removed by a magnetic separator. The metal may then be melted in an electric or open hearth furnace or in a rotary furnace similar to that in which the reduction is carried out.

Production of Steel

A PROCESS for the production of steel in the basic open hearth furnace, where a charge containing 1.6 to 2.4 per cent. of manganese is smelted to produce a steel containing 0.8-1.2 per cent. of manganese and then the subsequent oxidation is carried out more rapidly than usual, e.g., for a period not exceeding one-half the normal period so as to transfer the bulk of the manganese to the slag, is described in Specification No. 369,258, of Vereinigte Stahlwerke A.-G., Düsseldorf. Basic compounds, such as lime, are then added to the bath and the temperature of the melt is increased to at least 1,600° C. so as to transfer the manganese in the slag continuously into the bath. The heating is continued until the desired carbon content of the steel is reached, and the metal is then tapped. Additions of alloy constituents such as chromium, molybdenum, vanadium, titanium or tungsten may be made to the bath either in the furnace, during the tapping off or in the pan. Alloy steels containing 0.4 per cent. of chromium or 0.45 of molybdenum are referred to.

Steel Alloys

ALLOYS for articles such as seamless tubes, according to Specification No. 367,377, of H. J. Schiffler, Düsseldorf, are made from a ferric-pearlitic carbon steel substantially free from nickel containing at least 5 per cent. of chromium, 0.8-2.5 per cent. of silicon, 0.5-0.9 per cent. of aluminium, not more than about 1 per cent. of manganese and having a joint content of chromium, silicon and aluminium of not more than about 10 per cent. Up to 1 per cent. of the metals molybdenum, vanadium, and titanium, and up to 0.9 per cent. of tungsten, may also be present. An alloy suitable for cutlery, welding rods, etc., contains about 1.4 per cent. of carbon, 25-35 per cent. of chromium, 5-15 per cent. of nickel, 3.5-8 per cent. of silicon, the remainder being principally iron, is described in Specification No. 367,347, of F. B. Dehn, London. Welding rods made from this alloy are particularly adapted for forming a setting or holder for hard alloys, for example of tungsten, used in cutting, boring and drilling tools, especially for drilling well holes. The tool is faced by a deposit of the molten alloy from the welding rod and pieces of the hard alloy are embedded in the deposit.

Refining Iron

IN the refining of iron, as outlined in Specification No. 369,193, of the Syndicat des Laitiers et Scories, Paris, suitably selected oxides or salts are added to the slag during or after the fining process and the iron, etc., is agitated by any suitable means, the operation being preferably carried out during the blowing or after the blowing stage in a converter. The salts, etc., may comprise carbonates, chlorides, borates or sulphates of sodium, potassium, barium, calcium or magnesium or sylvinitic, either singly or mixed. Nitrates and chromates may also be added.

Molybdenum and Tungsten Alloys

ACCORDING to Specification No. 367,481, of J. Y. Johnson, London (a communication from I. G. Farbenindustrie), alloys containing molybdenum or tungsten or both are obtained by thermal decomposition of the metal carbonyls formed by the action of carbon monoxide under pressure on materials containing said metals which have been reduced in the presence of copper or its compounds. The copper-containing additions may be ores or waste products, and may contain in addition iron or other heavy metals, or compounds thereof, which themselves form carbonyls. The amounts of additional substances may be so chosen that the resulting carbonyls yield, on thermal decomposition, an alloy of a desired composition.

Recovering Tin and Zinc

THE recovery of tin from stanniferous materials low in gangue, such as ores, oxides, etc., containing or free from zinc is described in Specification No. 367,611, of Berzelius Metallhütten Ges., Wanheim, Duisburg, Germany. The material is mixed with a substance such as sodium carbonate or borax and carbon, and is heated in a muffle, electric, or other furnace, the temperature being so regulated as to preclude the formation of a molten slag, whereupon any zinc present distils off, and the tin and other metals are recovered in metallic form in the residues. In some cases the material is first preliminarily heated with a flux such as sodium carbonate under such conditions as to volatilise the whole of the zinc and a part of the tin as oxides, the greater part of the tin remaining behind, whereafter the residue is mixed with sodium carbonate and carbon and treated as above.

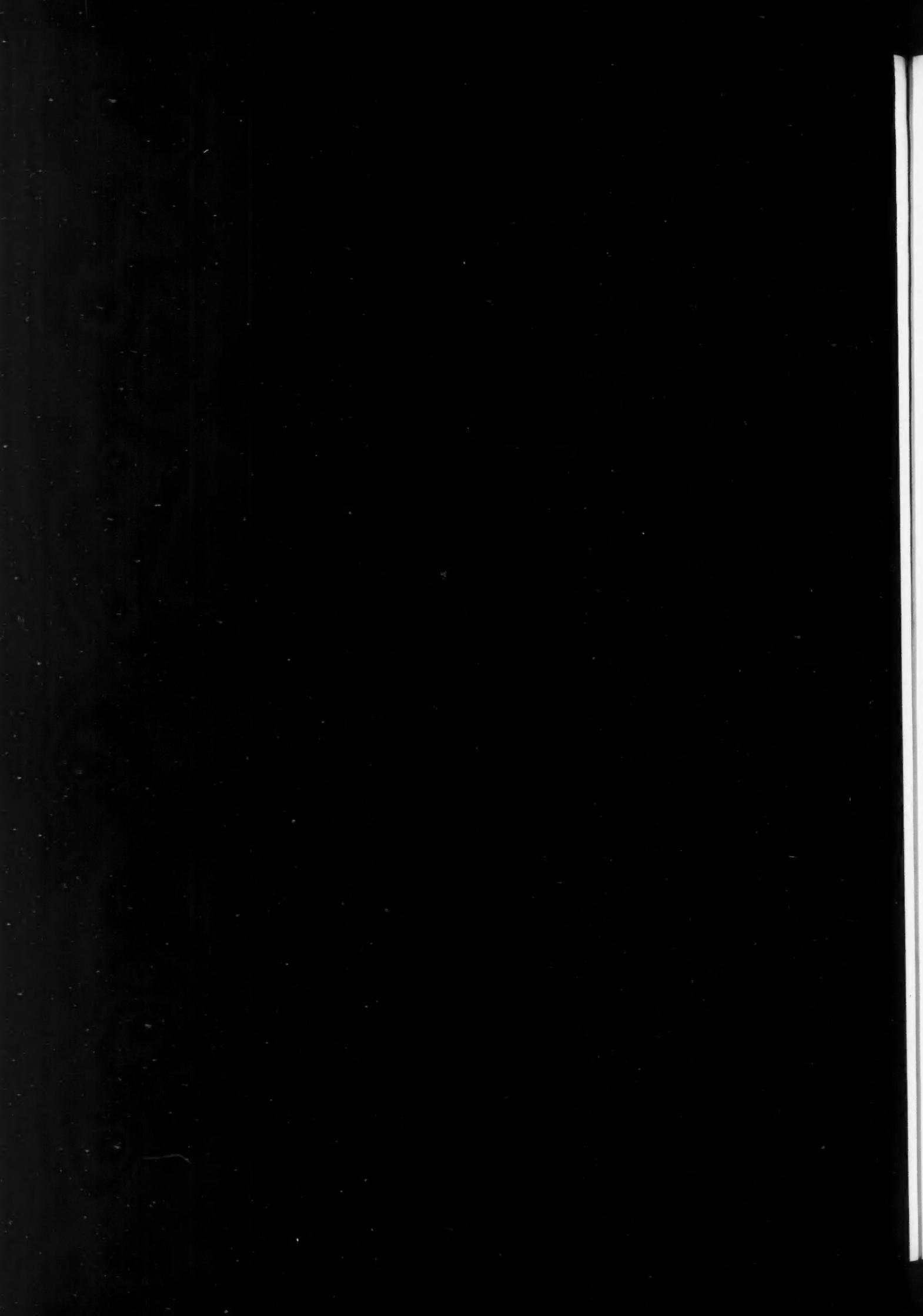
Annealing Corrosion-Resisting Iron

ALLOYS produced according to Specification No. 368,154, of the Babcock and Wilcox Tube Co., Pennsylvania, are stated substantially to preserve their physical and corrosive-resisting properties throughout a temperature range of about 480° C. to about 730° C. An alloy having a low carbon content is given a small grain structure by hot or cold working and is then cooled from a temperature such that the alloy will be ductile and the grain structure small. The temperature may be above but near the re-crystallisation temperature. The class of alloy to which this invention particularly relates contains 10.22 per cent. of chromium, 7.15 per cent. of nickel, a low carbon content of not more than 0.07-0.15 per cent., and sometimes small quantities of additional elements such as molybdenum, silicon, vanadium, tungsten and titanium.

Heat Resisting Nickel Alloys

A SUMMARY of compositions and properties of some representative nickel-chromium and nickel-chromium-iron heat-resisting alloys appears in the "Metallurgist" for May 27. The influence of addition elements, e.g., manganese, molybdenum, silicon, aluminium, is also discussed and reference is made to the influence of carbon content. The article forms a useful reference to the composition of a number of American and German proprietary alloys of these classes.

A CHART showing the main uses, in the United States, of nickel, in the form of alloys with chromium and with copper, in aluminium, zinc and other alloys, in cast iron, steel and iron-nickel alloys was published in a recent issue of the American "Metal Industry."



Metallurgical Section

August 6, 1932.

Current Topics

New Silver Alloys

WORK has lately been carried out on alloys of silver with zinc, cadmium and tin respectively, all of which were produced at a temperature of about 1150°C in a Méker gas furnace. According to a report which appeared in "Revue de Metallurgie" recently, the silver-zinc alloys containing 10 to 40 per cent. of zinc are characterised by high mechanical strength, and increase in the proportion of tin beyond 20 per cent. renders rolling and drawing progressively more difficult. It is interesting to note that the alloy represented by the formula $\text{Ag} \cdot \text{Zn}$, possesses a pink colour whereas all the other combinations of these two metals are white in appearance. One of the silver-cadmium alloys (50 per cent. Cd) is likewise endowed with a pink colour which changes into violet on ageing. Good rolling properties are possessed by silver-cadmium alloys with proportions of cadmium up to 40 per cent. The silver-tin system is peculiar in that a homogeneous alloy was not obtainable with a tin content of 10 per cent. and although better results developed from an increase in the tin content from 15 to 20 per cent. the mechanical properties of the resulting alloys were only moderately good. The investigators discovered that good rolling properties were possessed by an alloy of the composition: 80 per cent. Ag, 10 per cent. Zn, and 10 per cent. Cd.

The Manufacture of Cleaner Steel

BECAUSE steel makers have come to realise that in order to meet modern rigid specifications cleaner steel must be produced, a great deal of study has recently been devoted to methods for the effective de-oxidation of steel. Results of these investigations indicate that silicon-manganese alloys most quickly and thoroughly eliminate non-metallic inclusions from the bath. One of the most important factors affecting the rate of elimination of non-metallic inclusions is the size of the particles, since the rate of rise of these liquid particles is directly proportional to the square of their radius. To produce large inclusions it is necessary that the slags which form these inclusions be fluid at steel-making temperatures and have the proper surface tension so that they may readily coalesce. Actual tests on a large number of open hearth heats have shown that entirely satisfactory results cannot be obtained when manganese additions are followed by silicon, or when the de-oxidisers are added in reverse order. These methods of double de-oxidation are relatively inferior because the inclusions present do not tend to coalesce and rise rapidly to the surface. The addition of de-oxidisers in the form of suitable silicon-manganese alloys results in the formation of ternary oxide com-

bination which have the desired composition and fluidity to form large inclusions. Tests on ten open hearth heats show that particles formed on de-oxidation with the proper grade of silicon-manganese alloy have a rising velocity from 1,600 to 4,000 times as great as particles formed when only silicon additions are made. This subject which is of outstanding interest to all steel manufacturers, is discussed at length in an article which appears in this issue of THE CHEMICAL AGE.

Wider Uses for Molybdenum

THE use of molybdenum in forged and rolled steels has been well established for some time, but more recently it has proved a valuable addition with either nickel, chromium or manganese for cast steels. In this period of increasing numbers of high-pressure, high-temperature processes it has therefore been a fortunate discovery that the presence of a few tenths per cent. of molybdenum greatly increases the resistance of steel to creep at temperatures as high as $1,000^{\circ}\text{F}$. Shop experience shows that with the same Brinell hardness, molybdenum steels are easier to machine than other steel alloys. Molybdenum, however, is also credited with increasing wear resistance and has given satisfactory performance when used in shovels, dipper teeth and renewable wearing parts of rock-crushing, grinding and handling machinery. Manufacturers of ball bearings use a steel containing 0.2-0.3 per cent. molybdenum; an important railway company is now testing rails containing 0.70 per cent. carbon, 1.60 per cent. manganese and 0.40 per cent. molybdenum and the tests indicate that such rails will wear two to three times as long. Molybdenum has also been used in the construction of high-pressure boilers. Cast valves and fittings of the 5 per cent. chromium steel with the addition of molybdenum are especially adapted to the needs of the petroleum industry. Certain steels to which molybdenum has been added resist the action of hot sulphurous acid under pressure and may therefore be used as a lining for paper pulp digestors. In steel castings the general effect of molybdenum has been to increase the response to heat treatment and to promote depth hardening. In cast irons it seems to strengthen the iron without increasing its machining difficulties, and there also are indications that the iron possesses improved wear resisting qualities under conditions of elevated temperatures.

Bonded Metal

A BRIEF description of a new protected metal called "Robertson bonded metal" is given in the progress report of Mellon Institute for 1931-32. This product

is a laminated metal-felt combination in which felted materials are cemented to steel with heat and pressure, using other metals as the adhesives. The composite laminated material, of which the outer surfaces are felts, is then saturated with any desired saturant chosen with reference to the corrosive condition to which the metal is to be exposed in service. Paint, lacquer and resin films superimposed on the saturated felt give not only added protection but also desired attractiveness of appearance in the finished product. The ductile nature of the metal bond between felt and steel makes it possible to subject this material to forming operations such as shearing, bending, corrugating, rolling and mild drawing without destroying adhesion between felt and steel. Using asbestos felt and a suitable fire-proof saturant, the bonded combination gives increased protection over that for bare metal alone.

Cheaper British Steel

A NEW and cheaper process of steel manufacture is being operated at the Normanby Park Steelworks, near Scunthorpe, where John Lysaght, Ltd., have tackled the problem of co-ordinating and utilising the heat necessarily generated as by-products at various stages in the manufacture of steel. Previously the steelworks were operating under a great disadvantage against the Continental producer. The Lincolnshire ores have a low iron content, and a much larger amount of coke is needed in manufacturing pig iron from them than is required under the basic Bessemer process as operated on the Continent. It was therefore decided that if all the coke needed at Normanby Park could be manufactured at a modern plant close to the blast furnaces, the gas evolved in manufacturing the coke and that produced in the blast furnaces could be utilised together or separately for all the heat requirements in the making and rolling of steel from pig iron. With the newly organised works in full swing, waste of potential fuel has now been entirely eliminated. The blast furnaces, coke ovens and steelworks, instead of being isolated productive units, are linked in a logical sequence of production and utilisation of fuel, each type of fuel, whether blast furnace gas, coke oven gas, metallurgical coke or coke-breeze, being directed to the use in which its heat value is most efficiently employed. At the heart of this scheme is the new battery of coke ovens. These are the first in this country to be heated by blast furnace gas, and this method of heating (by means of a fuel which is low in heat value) frees the coke oven gas for use in other parts of the works. The cycle of fuel conservation is thus complete, and such an achievement should do much for cheaper British steel and the ultimate recovery of a basic industry.

Experiments in Welding

THE bulk of the Technical Report for 1930-31 of the British Engine, Boiler and Electrical Insurance Co. is devoted to an account of experimental investigations on fusion welding. It is stated that, in addition to many failures resulting from ill-advised repairs by fusion welding carried out during service, the company is meeting with a growing number of failures of parts that have been patched during manufacture. It is recognised that fusion welding, if done conscientiously and not used to conceal any portion of a defect, provides a highly useful method of correcting local errors introduced during

manufacture or local flaws originally present in the material, and that its judicious application is a legitimate means of preventing the scrapping of a vast amount of material otherwise sound, but it is emphasised that to prevent the increase of failures welding must be treated more scientifically, and highly trained welders, with material of good quality, must be employed. The use of ordinary bare wire electrodes for welding pressure vessels is regarded with disfavour. While there is justification, it is stated, for the claim that bare wire eliminates the entrapment of slag, it does not necessarily remove the danger of equally poor metal; inclusions may be present which are not accessible to the operator for removal. The principal objection urged against bare-wire welds as ordinarily made is, however, their low impact value. It is stated that the company would welcome the atomic hydrogen process for the welding of pressure vessels, especially when adapted for automatic welding, the special virtue it possesses being freedom from atmospheric contamination of both oxygen and nitrogen.

Data on Theoretical Metallurgy

A New Contribution

ACCORDING to Bulletin 350 of the United States Bureau of Mines ("Contributions to the Data on Theoretical Metallurgy: I. The Entropies of Inorganic Substances") the present trend in metallurgical research is toward application of the methods of thermodynamics to metallurgical reactions. Such methods have been used by the chemist for many years, but the metallurgist has been slower to appreciate their direct applicability to his problems and their exactness. Thermodynamic data on substances important in metallurgy are scattered throughout technical and scientific literature, and it is a primary function of the Pacific Experiment Station of the Bureau of Mines to collect and correlate these data and systematically to supply new data in cases where they are lacking or considered unsatisfactory. The present work is, therefore, an attempt to collect all the available data referring to one important thermodynamic property and to supply sufficient discussion to make the results readily usable.

In the study of chemical or metallurgical reactions two factors have predominant importance—the free energy of reaction and the speed of reaction. If one wishes to know whether or not an experimentally untested reaction is possible there is no surer, cheaper, or quicker means than the application of reliable free-energy data. For a possible reaction, or one that is well known, free-energy data definitely give the position of the reaction equilibrium under the various conditions required by experiment or industrial practice. Thus, it may readily be known without experiment (provided, of course, the necessary free-energy data are already available) whether a given chemical process is yielding the ratio of product to raw material that is thermodynamically possible. If the yield is smaller, means of improving the process may be indicated. On the other hand, since free-energy data are concerned only with the initial and final conditions of the reacting system, no information is given as to the speed of reaction or the mechanism, except that one is often able to eliminate mechanisms that were thought possible and thus to simplify the consideration of this phase of the problem.

It is the purpose of this Bulletin to give values of the entropies at 298.1° K. (25° C.) for those elements and common compounds, such as oxides and sulphides, for whose calculation the necessary data are at present available and to call attention to means of obtaining approximate values when data are lacking. The purpose of this publication, however, is not only to present recalculated figures in such form as to be readily usable by metallurgists but also to furnish a tabulation into which data that may become available in the future can consistently be inserted. Copies of Bulletin 350 may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., price 10 cents.

The De-Oxidation of Steel

Use of Silicon-Manganese Alloy

ANY method of obtaining cleaner steel is of vital importance to every steel manufacturer. This article, which is based on information supplied by the Electro Metallurgical Co., of New York, shows that the proper use of alloys of silicon and manganese in correct proportion leads to the formation of large slag particles which rise rapidly to the surface of the molten bath, with resulting decrease in the inclusions remaining in the steel.

FOR the past five years or more the United States Bureau of Mines, in co-operation with the Carnegie Institute of Technology and the Metallurgical Advisory Board, has been studying the physical chemistry of steel making. One of the important phases of this work has been a study of the various methods of de-oxidising steel. This investigation was carried out by a number of trained research men under the direction of Dr. C. H. Herty, and he and his associates have published a number of reports covering the results of their work. The results of these investigations show conclusively that alloys of manganese and silicon possess exceptional advantages for the manufacture of a clean steel.

In the manufacture of dead-killed steel it is customary to use silicon and manganese and at times aluminium or other strong de-oxidisers such as zirconium, calcium, titanium, or combinations of these, to kill the steel completely and to produce a steel as free as possible from non-metallic inclusions. The usual practice in the manufacture of the forging grades of steel has been to add silicon and manganese in the furnace in various ways and to complete the de-oxidation with silicon in the ladle. The silicon addition in the furnace was made to prevent the carbon dropping while the laboratory was checking the heat analysis, and the manganese to raise the manganese content of the finished steel to the specified percentage.

Elimination of Inclusions

A proportion of non-metallic inclusions are left in most dead-killed steels because: (a) sufficient time has not been allowed for the particles to be eliminated; (b) some of the particles are of such a nature that no matter how long the steel is allowed to stand they cannot be eliminated; and (c) some of the particles may be formed at the time of solidification of the steel by the precipitation of inclusion-forming material which is soluble in molten steel. A careful study of the reactions involved and microscopic examination of the type and number of inclusions found in steels de-oxidised with various alloys has led to the conclusion that the number of inclusions could be greatly decreased and their form and distribution so changed as to be less detrimental to the physical properties of the steel by a proper choice of the alloys used for de-oxidation.

The factors which affect the rate of elimination of non-metallic inclusions from steel are the size of the particles, the difference in density between the particles and the steel bath and the viscosity of the steel. The maximum rate of rise of a liquid particle in a liquid medium may be calculated from the above factors by means of an equation expressing what is known as Stokes' Law. The greatest variable in this equation is the term relating to the size of the inclusion particle, because it occurs as the square of the radius of the particle, and the particle size thus assumes a most important role in the elimination of non-metallic inclusions. Fortunately, this is the factor most readily controlled by the proper choice of a deoxidiser. Other factors that affect the extent of elimination of inclusions are the height of metal through which the particles must rise, the time between de-oxidation and casting of the steel and the ability of the slag to absorb inclusions—or conversely the ability of the inclusions to break through the slag-metal surface and be absorbed by the slag.

Large Inclusions

To produce large inclusions, it is necessary that the slags which form these inclusions be fluid at steel-making temperatures and have the proper surface tension so that they may readily coalesce. Practically no data are available on the surface tension of liquid slag but considerable data are available on the relative viscosities and melting points of many of the oxide systems.

A study of the melting points of the various combinations of oxides which may occur in liquid steel indicates that the

system $\text{FeO}-\text{MnO}-\text{SiO}_2$ offers the most favourable conditions for the formation of large inclusions. The lowest melting point of any combination of FeO and MnO (95 to 100 per cent. FeO) is about $2,500^\circ \text{F}$; that of any combination of FeO and SiO_2 (78 per cent. FeO) is about $2,235^\circ \text{F}$; that of any combination of MnO and SiO_2 (32 per cent. MnO) is about $2,245^\circ \text{F}$; and that of any combination of FeO , MnO and SiO_2 is about $2,200^\circ \text{F}$. This clearly shows that any method of de-oxidation which results in the formation of a slag consisting of iron oxide, manganese oxide and silica favours the formation of low melting point particles which readily coalesce and form relatively large particles which are rapidly eliminated from the steel.

Methods of De-Oxidising Steel

Three different methods of de-oxidising steel may be employed to obtain inclusions of this composition. Taking the first case of de-oxidation with manganese followed by silicon, when manganese is added to liquid steel containing FeO it reacts with the FeO , and some MnO is formed. The FeO that remains after such an addition, and a portion of the MnO formed, will be dissolved in the liquid steel. Any insoluble oxides resulting from this reaction between Mn and FeO would be binary oxides consisting of MnO and FeO . If now a silicon addition is made, silica particles are formed which will immediately tend to be fluxed by the dissolved FeO and MnO and any insoluble binary oxides of FeO and MnO present in the steel. Hence by varying the amounts of manganese and silicon added various slags consisting of FeO , MnO and SiO_2 may be formed. Theoretically at least, it is possible by this method to obtain fluid inclusion particles which would combine with each other to form larger particles which in turn would be rapidly eliminated from the metal, but actual tests have shown that entirely satisfactory results cannot be obtained by this method.

In deoxidation with silicon followed by a manganese addition, when silicon is added to a liquid steel containing FeO , particles of silica are formed which are fluxed by some of the FeO present to form insoluble binary oxides of FeO and SiO_2 . If after de-oxidising with silicon, sufficient FeO still remains in the steel so that some MnO could be formed by means of a manganese addition, some ternary oxide combination might also be formed. It is quite evident, however, that much difficulty would be encountered in attempting to form large fluid inclusions from this type of double de-oxidation, because silicon is such a strong de-oxidiser that there would be little FeO left for reaction with manganese, unless sufficient FeO had diffused from the slag into the metal to make the manganese-iron oxide reaction possible. The results obtained by Herty and his associates on a number of open-hearth heats killed with silicon, followed by a manganese addition, showed that large particles were not formed unless some iron oxide had diffused back from the slag into the metal. This method of double de-oxidation can, therefore, not be relied upon to give a clean steel and is inferior in this respect to the method in which the de-oxidisers are added in the reverse order.

Complete De-Oxidation

Complete de-oxidation of a liquid steel by means of a suitable silicon-manganese alloy results in the formation of inclusions of binary oxides consisting of MnO and SiO_2 . If the steel were only partly de-oxidised with such alloys, some FeO would remain dissolved in the steel which would flux with the manganese silicate in such a manner as to form ternary oxide combinations of FeO , MnO and SiO_2 which have the desired composition and fluidity to form large inclusions. While slags consisting of the three oxides MnO , FeO and SiO_2 may be produced by any of the three methods discussed, this particular method is by far the most satisfactory.

The work of Herty and Fitterer shows that not all silicon-manganese alloys are equally effective in causing relatively large slag particles to be formed. Alloys in which the ratio of manganese to silicon lies between 1 to 5 and 1 to 1, lead to the formation of inclusions similar to those formed when silicon alone is used. When alloys are used in which the manganese content exceeds the silicon content, larger particles are formed and there is a greater degree of elimination from the steel. The optimum results with a dead-killed steel were obtained by de-oxidising with an alloy in which the ratio of manganese to silicon was about 4 to 1, with indications that a slightly higher ratio would be somewhat better. It was found impossible to dead-kill a steel satisfactorily using an alloy in which the ratio of manganese to silicon was about 9 to 1, but this alloy gave the best results of any tested in the de-oxidation of a semi-killed steel. A general conclusion from the results obtained on small experimental heats is that alloys with from 3 to 9 parts of manganese to 1 part of silicon will form large inclusions which are rapidly eliminated from the steel. Results on both basic and acid open-hearth steels, varying from 1.02 per cent. to 0.60 per cent. in carbon content, treated with silicon-manganese alloys have in every case shown that the best results were obtained when the ratio of manganese to silicon was between 4.5 to 1 and 6.0 to 1.

The Mechanism of De-Oxidation

The mechanism of the formation of these large particles involves several important factors, some of which are not well understood. Upon the addition of silicon-manganese alloy to a liquid steel, it must first dissolve in the steel, and then manganese and silicon can react with FeO to form MnO and SiO₂. The SiO₂ is but slightly, if at all, soluble in liquid steel at ordinary steel making temperatures and so innumerable small globules of SiO₂ are formed. The MnO, on the other hand, is appreciably soluble and no MnO particles will form unless its saturation point has been exceeded, which is unlikely in most steels. At this point each silica particle is surrounded with steel containing some MnO and possibly a small amount of FeO, and it immediately starts to absorb the MnO and FeO dissolved in the steel to form a ternary oxide slag consisting of SiO₂, MnO and FeO. As this absorption proceeds, the silicate slag particles not only increase in size but become more fusible and fluid, and collisions between particles are more likely to result in their coalescing than if the particles were of pure SiO₂. Hence, large inclusions are formed by these two processes, namely, the absorption of MnO and FeO by SiO₂ from the surrounding steel and the accidental collisions of the particles.

Size of Particles

The large particles formed on de-oxidation with a silicon-manganese alloy of the proper composition rise in the steel bath at an extremely high speed compared with the speed at which small silica particles rise. The calculated maximum rising velocity of particles of different sizes and the time required to rise through 30 in. of steel, the average depth of the open-hearth bath, and through 12 ft. of steel, the average depth of a steel ladle, are shown below.

Size of Inclusion (in.)	Maximum Rising Velocity (in. per min.)	Least Time Required to Rise Through:	
		30 in.	12 ft.
0.0002	0.06	493	2360
0.0004	0.24	122	587
0.002	0.12	4.93	23.60
0.004	24.45	1.22	5.87
0.02	612.00	0.05	0.24

Previous investigations made by Herty and Fitterer on the de-oxidation of steel with silicon showed that the average size of the particles formed was 0.0006 in. In their more recent work on the use of silicon-manganese alloys, much larger inclusions were formed. In an ingot which had been de-oxidised with an alloy in which the ratio of manganese to silicon was 4 to 1, the average size of the largest inclusions was 0.04 in. The above table indicates that particles 0.0004 in. in diameter or larger formed on de-oxidation would probably be eliminated from the open-hearth bath before a sample could be taken. It has often been noted in sampling

large heats de-oxidised with the proper grade of silicon-manganese alloy that samples taken 3 min. after the addition contained only a small amount of non-metallic matter, even though the steel was highly oxidised before the addition. In tests taken immediately after the addition, manganese silicates were found on top of the small test samples.

It is interesting to compare the rate of rise of the inclusions formed on de-oxidation with these silicon-manganese alloys with the rate of rise of inclusions formed on de-oxidation with silicon. Actual tests on the average rate of rise of the particles in ten open hearth heats de-oxidised with silicon showed this to vary from 0.15 to 1.5 in. per min. The large particles formed on de-oxidation with the proper grade of silicon-manganese alloy have a rising velocity of 600 to 2,400 in. per min., that is, from 1,600 to 4,000 times as great. It is evident from this that a steel de-oxidised with the correct grade of silicon-manganese alloy should be a much cleaner one than a steel de-oxidised with an alloy that does not cause the formation of large, rapidly rising particles.

Advantages of Silicon-Manganese Alloys

While the greatest advantage in the use of silicon-manganese alloys lies in the type of slag particles formed, resulting in a much cleaner steel, this is by no means the only advantage. One decided advantage is that the recovery of manganese is uniformly high, so that the alloy is kept low and final manganese specifications are easily met. Due to the low melting point and high concentration of the alloying elements in these silicon-manganese alloys the speed of reaction is high, and the temperature of the steel bath is increased with a consequent decrease in its viscosity. This favours the elimination of slag particles and shortens the time of making an open hearth heat, sometimes by as much as 15 or 20 min. The complete de-oxidation and increase in temperature of the steel which are obtained through the use of these alloys also aid greatly in obtaining a rapid and complete solution of alloying elements, such as chromium, in the production of alloy steels. There is also a considerable improvement in the surface of blooms when the steel has been made with the use of silicon-manganese alloys.

Ore Minerals

Technique of Microscopic Determination

THE optical and micro-chemical study of opaque minerals is now reaching a mature stage in its development. The most recent work on the subject in English ("U.S. Geol. Surv., Bull." 825, 1931, pp. 204) has been written by M. N. Short, who has himself been occupied with the investigation of improved methods during the last four years. From a research point of view, the book is noteworthy because, for the first time, full determinative tables are given incorporating the effects of polarised light on polished surfaces of ore minerals. A far-reaching and critical study of qualitative micro-chemical tests for elements forms the basis of another and equally useful set of determinative tables. A combination of these two methods with the etching processes devised by Davy and Farnham, Murdoch and others brings the whole technique up to the level of reliability attained by the better known petrographic methods involving the use of transmitted light.

The work concludes with a list of specific tests for minerals, the latter being arranged alphabetically. It is obtainable from the Superintendent of Documents, Washington, D.C., price 60 cents.

Metalliferous Mining Industry Committee

THE Secretary for Mines has appointed Mr. R. Arthur Thomas, a member of the Advisory Committee for the Metalliferous Mining Industry, to be chairman of the Committee in place of the late Mr. J. J. Burton. He has also appointed Major W. D. Barratt to be a member of the Committee as a representative of owners of iron ore mines and quarries in place of the late Mr. W. W. Casson, Mr. E. J. Fox as a representative of the iron and steel industry vice Mr. Burton, and Mr. E. Archer as secretary to the Committee vice Mr. F. C. Starling.

Production of Copper Sheets

A New Electrolytic Process

A NEW process for the production of copper sheets in one operation has been developed by Sherard Cowper-Coles, of Sunbury-on-Thames. The process is one of electrolytic refining and deposition, the copper being deposited on a revolving drum, a number of which are worked in series. Various attempts have been made to produce sheets in a similar manner by an electrolytic process, such as the Elmore, Dumoulin and other processes, but they have never reached the stage of commercial success by reason of the slowness of the process, the large amount of scrap metal produced and the fact that uniformity of product could not be ensured. These difficulties are now claimed to be overcome by the Cowper-Coles process, sheets equal to those obtained by rolling being produced in one operation from ingot. The process is one of building up, not breaking down, and therefore very thin sheets can be made as cheaply as thick sheets, except for the small extra labour of handling a greater number of sheets per ton, whereas in rolling the extras on very thin sheets are as much as £10 per ton per gauge. The new process also enables the thinnest sheets to be produced in any size up to

12 ft. x 4 ft., the time taken being 15 minutes or more according to the thickness required.

This new process enables small units to be worked very economically, for example, a five ton per week unit; rolling mills, on the other hand, require a large output to give economical results. Both in hot and cold rolling the amount of scrap is very considerable, varying with the gauge, the thinner the gauge the greater being the amount of scrap. The new process overcomes this drawback, the amount of scrap being reduced to about 1 per cent. The scrap produced also has an increased value, as it has been refined during the process of deposition and fetches the highest market price. It is claimed for the new process that the copper can be made so hard, without any after treatment, that it can be used for spring contacts in place of phosphor bronze, whilst retaining the advantage of pure copper with its high electrical conductivity. The process also readily lends itself to the production of bi-metal sheets, such as copper sheets faced with tin or nickel to any desired thickness for stampings or spinnings.

The Properties and Uses of Molybdenum

Some Recent Researches

THE effects of adding molybdenum to cast iron are dealt with in a brochure which has been published by the Molybdenum Corporation of America. Copies of this brochure are being distributed in this country by High Speed Steel Alloys, Ltd., of Widnes, Lancashire.

Molybdenum has been an invaluable aid in the production of better grey iron, giving higher strengths, greater wear resistance and aiding materially in the prevention of growth. With a view to adding to the data on molybdenum irons, particularly molybdenum-chrome and molybdenum-nickel, a base iron was used of an analysis which was considered typical of the medium strength irons made to-day. This iron was a compromise between the coarse, open grain, 20,000 lb. iron and the high strength irons of 40,000 lb. and above. In order to have exact control over composition and temperature while pouring a series of test bars, an experimental electric furnace was used as a melting medium. All samples were made in an automatically controlled Lectromelt furnace, using 400 lb. charges, comprising 50 per cent. pig iron, 25 per cent. cast scrap, 15 per cent. railroad malleable scrap, 10 per cent. steel, and the alloys added were ferro-molybdenum 62.12 per cent., ferro-chrome 70 per cent., nickel shot 92 per cent.

Increase in Strength

In both the high and low molybdenum series with nickel, the tensile and transverse strength increased as the percentage of nickel increased. In the chrome series with low and high molybdenum, the tensile strength reached its peak at about 0.20 per cent. chrome, the transverse strength at about 0.1 per cent. chrome. The increase in strength was due to the finer and more nodular graphite in the alloy irons and to the strengthening of the matrix. With slight increases in both nickel and chrome with molybdenum, deflections were augmented, though with increasing percentages they were lowered. Machineability on low-molybdenum-nickel is only slightly affected. Maximum machineability on high molybdenum was obtained with 0.31 per cent. nickel; above this the machineability gradually decreased as that alloy increased. Brinell hardness in all series was increased as the chrome and nickel is increased.

It is therefore concluded that where increased strengths and good machining properties are desired, the molybdenum-chrome and molybdenum-nickel irons offer splendid opportunities. The alloys can be added to ladle or furnace with excellent recoveries. It must be emphasised, however, that the results of adding molybdenum or in fact any alloy material to cast iron depend on the general composition of the iron, and that their addition to unsuitable mixtures will not give satisfactory results.

General information in regard to the occurrence, production, properties and use of molybdenum is given in Economic Paper 15, just published by the United States Bureau of Mines. Molybdenum is a relatively rare element, but the United States is fortunate in possessing abundant resources, sufficient to supply not only the needs of domestic manufacturers, but also a large proportion of the requirements of European consumers. Moreover, molybdenum is the only important special steel-alloying element in which the United States has demonstrated its self-sufficiency. As little as 0.25 per cent. of molybdenum is an effective hardening agent when incorporated in alloy steel, and heat-treated steels containing molybdenum are more ductile than many other similar alloy steels.

Varying Properties

Pure molybdenum is a silvery white, malleable metal, softer than steel and capable of being filed and polished; its specific gravity is about 10, or not quite as heavy as that of lead. The metal may be produced in several ways, and its properties vary accordingly. If prepared by the reduction of molybdenum oxides with hydrogen it is a grey metallic powder, which may be compressed under heat and pressure into brittle bars. If the oxide is reduced with carbon an impure grey powder results, of which the specific gravity is about 8.75, due to the presence of carbon. In this form it is harder than quartz. Molybdenum is also manufactured by a chemical process, which gives a dark-blue, metallic, crystalline powder. The melting point of the pure metal (about 2,500° C.) is higher than that of platinum. Electrically it is a good conductor; it is stronger and harder than copper, but softer and more easily worked than tungsten. Alloyed with steel it acts much like tungsten but is more potent. It likewise is very similar to chromium in the properties it imparts to steel, but much smaller quantities are required to produce the desired result.

Molybdenum is consumed principally in the steel industry. Smaller quantities, in the form of wire and sheet, are used as supporting filaments in incandescent lamps and radio tubes; and an additional quantity, in the form of oxide, is absorbed by chemical industry. Alloy steels containing molybdenum are used in many fields, but are employed extensively in aircraft and in motor cars. All nitriding steels contain molybdenum, and in high-speed steels molybdenum may be substituted for tungsten. It is a valuable addition to rustless, heat-resisting, and acid-resistant steels and to grey iron castings and steel castings; it enters into alloy-steel guns and armour plate, saw steels, die steel, razor blades, and countless other products. Copies of Economic Paper 15 may be purchased from the Superintendent of Documents, Government Printing Offices, Washington, at 10 cents.

Antimony Smelting in California

By W. BRAZENALL

The following article is reprinted from a recent issue of "Chemical Engineering and Mining Review," and is of particular interest in view of the technique which is described.

WHEN the great war began in 1914, The Western Metals Co., of California, was formed to smelt and refine antimony exclusively. A site was purchased at Harbor City and the first unit consisted of a blast furnace (water-jacket type), with one small reverberatory furnace for doubling and a six-hole crucible furnace for stirring the metal. The blast furnace was 5 ft. x 20 in. at tuyeres with six tuyeres $1\frac{1}{2}$ in. diameter. The shaft of the furnace was 19 ft. high to the charging floor, where a hood was fitted and a flue pipe leading down to the flues underground which led to the bag-house, containing 25 bags 20-in. diameter x 20 ft. long suspended from beams at the top of the bag house.

A small unit of the Cottrell process was installed for experimenting with the object of collecting the escaping oxide. This consists of 20 vertical tubes 25 ft. high and 10-in. diameter connecting with the chambers top and bottom. Rods were suspended from the top of these tubes through which a current of 10,000 volts was passed, the current being taken from the high-tension line of the Pacific Electric lines running into the plant. The Cottrell process was partially successful at the time, but was discarded for the bag-house owing to the non-continuity of the electric magnetic current. This was caused by the accumulation of the oxide on the rods preventing the current from further action until it was shaken off, which was done after cutting off the current.

Blast Furnace Operations

The fumes carried over from the blast furnace consisted of a sulphy-oxide of a dark red amorphous powder which contained from 10 per cent. to 15 per cent. sulphur, as the furnace was operated with a cold top. Advantage of the sulphur content was taken to burn itself free by stacking the sulphy-oxide in kilns or brick walls, igniting the sulphur in it and allowing it slowly to smoulder away, leaving it in the form of a comparatively clean oxide. This was charged in the reverberatories and reduced to metal.

The ores were obtained chiefly from the company's own mines in the Mojave Desert, California, Mexico, Chili, and Alaska, and consisted mainly of silicious sulphides, although considerable oxide was obtained from Sonora, Mexico. The charges of the blast furnace were elevated to the charging floor by an electric elevator, being weighed in iron wheelbarrows and wheeled to the elevator. The charges consisted chiefly of sulphide ores and were as follows:—Coke, 350 lb.; sulphide of antimony, 810 lb.; tap cinder or metallic iron scrap, 350 lb.; limestone, 550 lb. The aim was to produce a well-balanced slag in order to ensure efficient running of the furnace. The following was the average content of the slag that gave satisfactory results:— SiO_2 , 4 per cent.; FeO , 27.5 per cent.; CoA , 28.2 per cent.; Sb , 0.7 per cent. The blast furnace treated approximately 18 tons of the silicious ores per 24 hours' shift. The metal obtained from this furnace consisted of singles, *i.e.*, the metal containing approximately 5 per cent. to 7 per cent. iron.

Lighting Up

Before lighting up the furnace for a campaign the fire was kept on the hearth for a few days to get the bottom well heated. Wood was then filled in for lighting and coke for the first 6 ft.; then alternate layers of coke and slag from the previous charge were charged in sufficiently to fill the forehearth; then the regular charge was carried on. The first lot of slag was used to fill the forehearth by allowing the furnace to fill up the tuyeres with slag and then tapped into the forehearth every five minutes until it was full to overflowing, when the top was chilled by throwing water on the top to make a good crust, after which a hole was broken through it under the spout from the furnace and the overflow opened.

When the furnace was tapped into the forehearth the metal settled out in the forehearth and the slag flowed out from the overflow spout. The antimony and matte settled inside the forehearth, and the slag flowing out was comparatively clean, although after testing it was found that prills

of antimony were formed in the pots. It was decided after experimenting that by tapping the slag from one pot to the other, the slag remaining in the form of a skull in the first slag pot contained about 3 per cent. antimony, while the slag tapped out into the second pot was comparatively clean. The skull from the first pot was charged with the ordinary charge, a good flow of slag being necessary to ensure a good reduction of metal within the furnace.

This furnace was run in campaigns of about two months, depending on the supply of ore, and then closed down when ore supplies ran out. The metal from this furnace was then smelted in a reverberatory and sufficient sulphide ore added to it to remove the iron in the metal. This process was termed doubling. It was then tapped into moulds on a truck on rails which were laid under the tap hole, and as they were filled moved along, the dross being skimmed off the surface, leaving the metal covered with crystals of antimony.

Starring the Metal

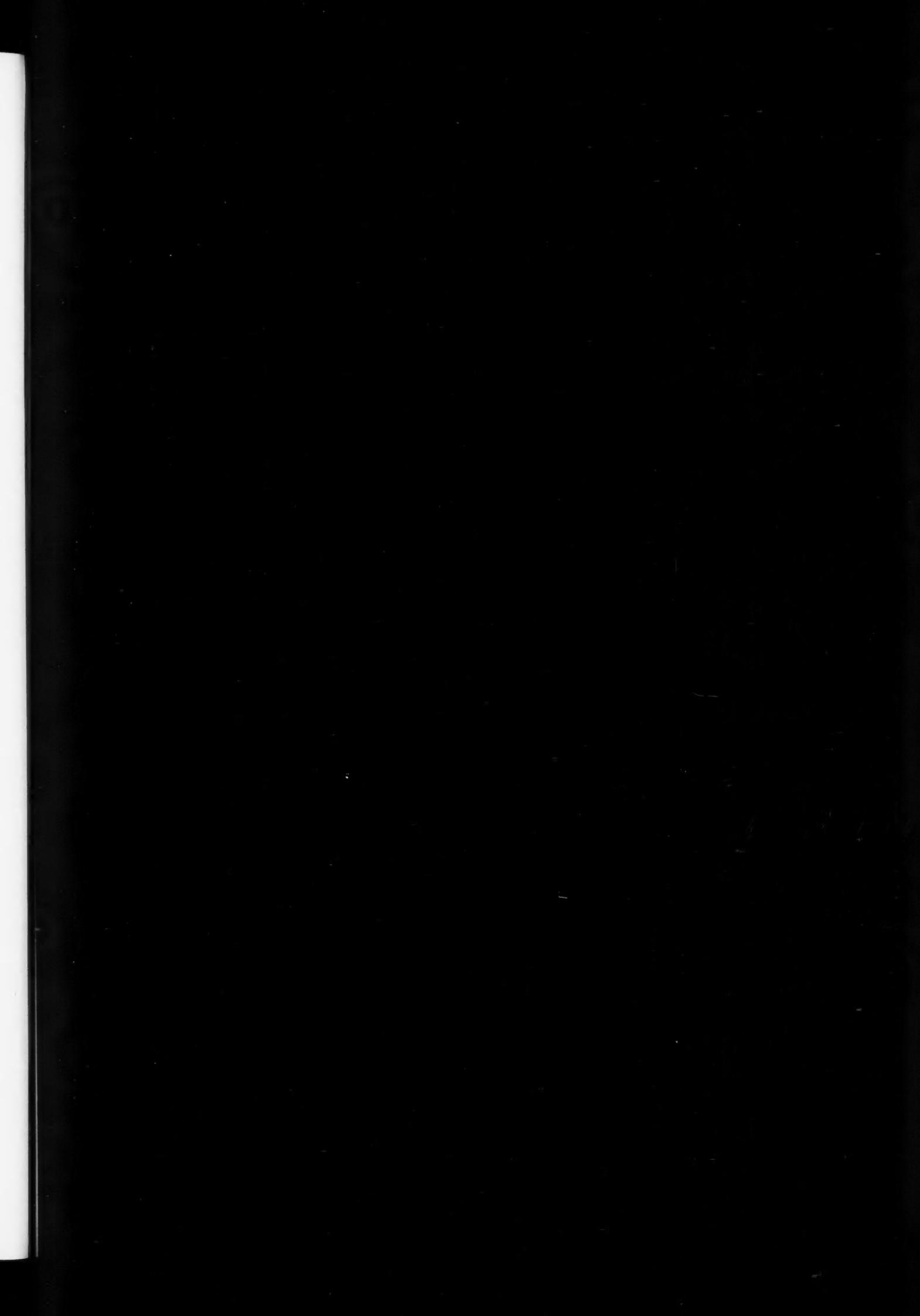
The starring of the metal consisted of breaking the double metal into 2-in. cubes and charging it in crucibles together with carbonate of potash slag, especially made and called flux. The crucibles were placed in the crucible furnace, especially built into the floor, which had six holes, each holding one No. 30 crucible, with a capacity of 98 lb. of metal and 3 or 4 lb. of flux. The crucibles were heated by crude oil, the flame being arranged to pass around them, smelting the charge in about 45 minutes. It was then lifted out with tongs and placed in a bow made with handles for pouring the metal from the crucible, similar to a ladle. The moulds were placed together in pairs so that two could be poured at once, each weighing about 45 to 46 lb. By placing a triangular piece on the joining edges of the moulds the stream of metal was divided equally between the two moulds, allowing the slag to cover the metal.

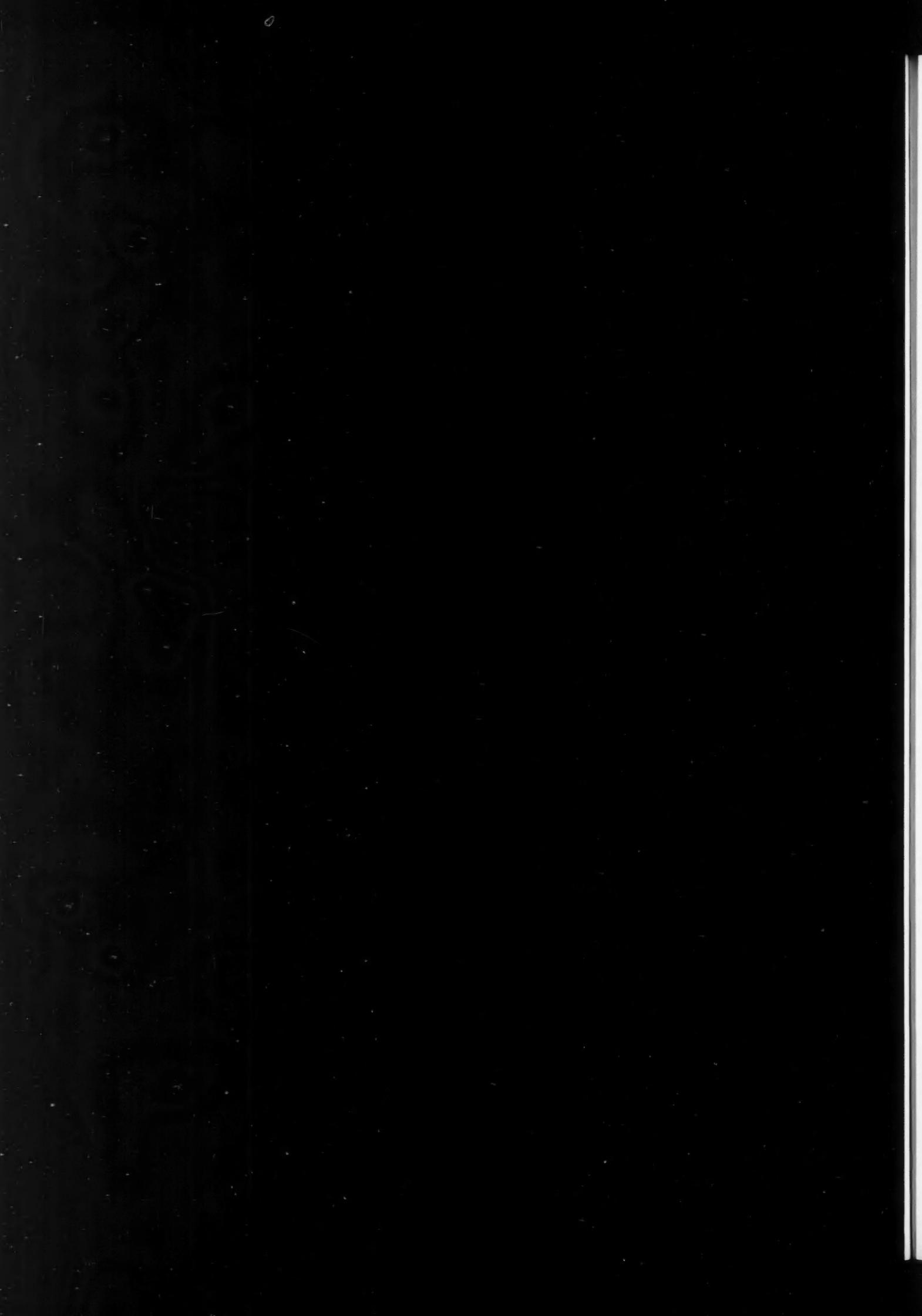
After the first year of the war the cost of crucibles became prohibitive and other methods had to be used to obviate the use of them, and considerable experimenting was done. Finally, the double metal was tapped in ladles together with sufficient flux that had been prepared in another furnace and then poured in the ordinary way. The metal was cleaned of slag by chipping with picks made for the purpose and also by washing, as the carbonate of potash slag was very deliquescent. It had to be cleaned thoroughly, otherwise it stained the metal, causing it to lose its bright appearance.

Volatilisation Process

After two years of the above practice it was decided to change from the precipitating method to the volatilisation method and a blast furnace working with a hot top was erected, the same size as the first blast furnace, only having 3-in. tuyeres and supplied with blast from a 10-in. Sturtevant blower of the fan type, discharging blast at water pressure of $1\frac{1}{2}$ in. As it was intended to volatilise all metal contents of the ore into oxide, a hot top was maintained throughout and the whole of the metal contents put into oxide. A large Sturtevant 100-in. exhaust fan with a 30-in. discharge was used to draw off the gases and fumes and discharge them into the especially large bag house erected for the furnace, containing 120 woollen bags 20 ft. long and 20 in. diameter and connected with large chambers beneath for collecting the oxide. These chambers were fitted with valves so that each chamber could be shut off to enable it to be cleaned out whilst the others were in operation.

Much of this oxide was used in the manufacture of porcelain and had to be kept to a certain solubility test and had to be a good white colour. Consequently great care had to be exercised in regulating the heat on the top of the furnace. Pyrometers were used in order to keep the temperature at the right degree to ensure good colour. This oxide was packed in barrels by machinery, each barrel holding from 800 to 900 lb. After installing the volatilisation process all ore was made into oxide and the carbon and soda added and then charged into the reverberatory and reduced to metal in the usual way.





Metallurgical Section

September 3, 1932.

Current Topics

Age-Hardening of Nickel Alloys

THE 1932 lecture to Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, which has been reprinted, gives a comprehensive survey of the present state of knowledge on age-hardening. An introductory discussion of the theoretical aspects of the subject includes a critical analysis of the mechanism of the various forms of age-hardening and a table showing the range of metals known to be susceptible to age-hardening, together with solubility data on the addition elements capable of producing hardening in the various metals. Reference is made to the hardening properties of nickel and nickel alloys and to the use of nickel in conjunction with other elements as an age-hardening agent. Age-hardening in aluminium alloys is discussed in some detail, and attention is directed to the fact that the aluminium-copper-nickel and nickel-silicon-copper alloys, like Duralumin, age-harden with little or no physical evidence of actual precipitation of the hardening constituents. The phenomenon of suppressed transformation hardening, as occurring, for example, in steel, is illustrated by reference to the aluminium-zinc and copper-gold systems. A further section of the lecture deals with the relation between susceptibility to age-hardening and the character of the alloy system and its two components, solvent and solute, and with their influence on the mechanical properties and hardness obtainable in the finished alloy. The value of age-hardened alloys in the high-temperature field is emphasised by reference to the strength at elevated temperatures obtainable in aluminium-copper-nickel and titanium-cobalt-iron (Konel) alloys. The influence of dispersion-hardening on other physical properties, and the limitations imposed by intergranular precipitation are discussed. The final section of the paper deals with heat treatment of age-hardening alloys and with factors having an accelerating or a retarding influence. A very comprehensive bibliography is included in the reprint.

World Trade in Arsenic

SWEDEN, which produced practically no arsenic prior to 1926, has suddenly leaped into prominence and may shortly become the dominant factor in the world supply. The copper ores treated at the new Boliden smelter, on the Gulf of Bothnia, contain unusually large percentages of arsenic in addition to high gold values and some silver. The disposal of this arsenic has already proved a serious problem, and recent reports indicate a possible production at the rate of over 50,000 tons annually, or more than the present world total. In as-

much as world consumption outside of the United States is probably less than one-third of the proposed output of this one plant, developments will be watched attentively by those interested in the industry. Already a huge concrete structure has been built for storage of large stocks of material in the event that it cannot be sold. Prior to the outbreak of the world war, the apparent world production of arsenic rose gradually to about 10,000 tons annually; in 1920 it reached 25,000 tons, and still later 45,000 tons. Germany was the leading producer, but the United States and Canada were becoming increasingly important. England, during the full activities of the Cornish tin mining, produced even more arsenic than Germany; Portugal was another large producer. Other countries, including Japan and Australia, had scarcely entered the field. In recent years, however, the United States has become the leading producing country, and Mexico is easily second. Germany has increased her output, but is now a relatively small factor in world supply.

Technology of Arsenic Recovery

IN Europe, metallic arsenic is produced by the sublimation of mispickel or white pyrites in the absence of air. The arsenic vapour collects in crystalline crusts near the mouth of the retort, while pulverulent arsenic, which can be used only for working up arsenic products, is caught in the cooler parts of the condensing system. The residues as well as raw ore may be roasted for arsenic trioxide, and the sublimed white arsenic collected from the gases in a series of chambers. In the United States, metallic arsenic has been made in the past from white arsenic, but the cost was two or three times as much as in Germany. White arsenic has been made from arsenical gold ores, the residue in the roasting furnaces being smelted to recover its metal content. At the copper and lead smelters, the flue dusts may be smelted in a reverberatory furnace producing a matte and volatilising arsenic again. Lead bag-house dust, carrying about 30 per cent. arsenic, is sometimes mixed with sulphides and roasted, the clinker being sent to a blast furnace, and enriched arsenical dust being obtained for subsequent treatment. The roasting operations may be carried out in muffle, reverberatory, or any other type of roasting furnaces, and the crude arsenic trioxide is collected in cooling flues, bag-houses, or by electrostatic precipitation.

The crude dusts are resublimed until the desired colour and purity are obtained, coke, gas, or oil being ordinarily employed instead of coal in order to reduce contamination of the product with soot.

Protective Coatings on Steel

THE effect upon the resistance of metals to fatigue when coated with some other metal has been found to be dependent upon the nature of the bond between the metal and the coating. It has previously been shown by numerous investigations that the surface condition of a metal is an important factor in determining its resistance to repeated stresses. Surface alterations caused by corrosion, either previous to or coincident with stressing, are known to cause a marked lowering of the normal endurance limit of metal. Metallic coatings, which are widely used to protect iron and steel from corrosion, may also appreciably improve the resistance of metals to simultaneous stress and corrosion, but the effect of protective metallic coatings upon the endurance limit of metals when corrosion is not involved has only recently been studied. Tests carried out at the United States Bureau of Standards have included the effect of hot-dipped galvanised coatings and of electro-deposited zinc coatings upon the endurance limits of open hearth ingot iron (contain-

ing 0.02 per cent. carbon) and two carbon steels (containing 0.45 per cent. and 0.72 per cent. carbon). Endurance limits were determined on specimens of each material when polished but uncoated, when galvanised by the hot-dip process, when zinc electro-plated, and when acid-pickled as for galvanizing. The ingot iron was tested in the hot rolled condition; both of the carbon steels were tested in the normalised and annealed, quenched, and tempered conditions. The acid pickling caused a decrease in endurance limit of as much as 40 per cent., the greatest decrease occurring in the quenched steels. The presence of a galvanised coating caused a still greater decrease in most of the materials, the maximum, 42.5 per cent., being obtained in the quenched or the tempered steels.

The endurance limits of the electro-plated materials were equal to or greater than those of the polished, uncoated materials. The difference in the effects caused by the two types of coating is believed to be a result of the differences in the nature of the bond between zinc and steel and in the structure and hardness of the coatings.

The Slag Problem in Iron Foundry Practice

By J. E. FLETCHER

The following extracts are taken from an article which appears in the current issue of "Fuel Economy Review." The author, Mr. J. E. Fletcher, is consultant to the British Cast Iron and Wrought Iron Research Associations.

LITTLE serious attention has been given to either the practical or theoretical functions of the slags formed during the melting of cast iron in the foundry cupola. There is a kind of family connection between blast furnace and cupola slags, both containing alumina, silica and lime in considerable proportions. In the case of blast furnace slags, these three constituents are traceable to the ore and flux and as the weight of slag per ton of iron produced is of the order of 15 to 30 cwt., there is little difficulty in estimating the analysis and their proportions in the furnace burden when producing pig iron of known analysis. Eroded products do not greatly influence the analysis of the slags except when the furnace lining is being intensively eroded.

In the foundry cupola the weight of slag produced per ton of iron melted is generally from 80 to 130 lb. and it is not easy to estimate the slag analysis. Apart from the lime and magnesia in the ordinary fluxes, the silica and alumina contents are largely influenced by the character of the melting processes, some of the silica coming from oxidation of the melted metal, some from the sand coverings on the pig iron and scrap, and the remainder from the eroded or fused lining materials and coke ash. The alumina in the slag is mainly derived from the eroded lining material and the remainder from the coke ash and sand covering on the pig iron and scrap. The iron and manganese oxides in the slag mainly come from oxidation of the metal during melting and the remainder of the iron oxide results from the rust covering of the scrap and pig iron. The only slag-producing ingredients which can be traced with any certainty, quantitatively, are the lime and magnesia from the flux for, with the exception of the comparatively small amount of lime escaping with the chimney gases, the lime and magnesia contents can be estimated in terms of the weight of metal melted and are the only closely approximate index in a cupola slag analysis to the weight of slag produced per ton of metal melted.

If the analysis of the coke and of the coke ash is known, the alumina content is an index to the amount of wastage of the lining materials, when the analysis of the refractories is known. The oxide of manganese content is an index to the amount of manganese lost by the metal from oxidation during melting. The two remaining oxides, silica and iron oxide, are the most variable and it is always difficult to trace the amount due to the sand and rust on the scrap and pig iron coverings, and that caused by the oxidation of the metal during melting.

Many of the defects in iron castings can be traced to the presence of gases and non-metallic inclusions in the molten metal. In the Bessemer convertor, blast furnace and foundry cupola air streams traverse or play upon the molten metal and slag. The blast also impinges upon the refractory linings which are always, at the high temperatures obtaining, filmed with flowing or dribbling streams of slags changing in composition during the blow. Though in the cupola the weight of slag produced is only about 100 lb. per ton of iron melted whilst that produced in the blast furnace may often reach 30 times that amount, the smaller bore of the cupola hearth brings the low pressure blast streams into much closer contact with the metal and slag streams. The air jets of the cupola impinge upon the incandescent coke whose temperature may reach 1,600° C. to 1,800° C. and it is certain that the drops of iron in contact with the hot coke have their skins heated to these high temperatures and become oxidised.

In the cupola the softer blast used oxidises the metal much more feebly but the small drops of molten metal are materially affected by the air blast; oxides of silicon, manganese and iron being formed, some of which remain suspended in the molten metal and may or may not rise and be carried off in the slag. In most foundry cupolas the air blow into the lower portion of the coke bed is in excess of combustion requirements and even when the exact amount for the formation of CO_2 is supplied, combustion is only partially completed at the top of the coke bed, a considerable percentage of free oxygen being present in the zone extending some 20 inches immediately about the tuyeres, which accounts for the oxidising character of the gases in this zone.

Limestone, chalk or fluorspar are added to the cupola charges in order to mix with the coke ash, sand and rust coverings of the pig iron and scrap, and with the products of metal oxidation (SiO_2 , MnO and FeO) to form a free-running slag. Without these additions a very viscous and scouring slag would be formed, disastrous to the linings and useless as a desulphuriser. During the melting operation the sand and rust coverings of the pig-iron and scrap, with the lime after CO_2 has been expelled from the limestone, descend to the level of iron smelting temperature, about 1,140° C. This level may be some distance above the top of the coke bed and the slag-forming constituents must descend to the top of the coke bed before fusing and forming the first type of slag. The coke ash is not slagged freely before it approaches the

superheating zone in the coke bed and the mixture of the primary and coke-ash slags must descend to the tuyere zone before slag is formed, running into the cupola well, where it floats upon the molten metal. The final slag contains eroded lining material from the cupola walls, the erosion products coming principally from the superheating zone where the temperature is highest and the impact of the oxidised metal and slag driven by the blast against the lining greatest.

Scavenging Dopes

As far back as 1867, Horsley, of Derby, found that additions of alkalies to molten iron had the effect of removing sulphur and since that time many proprietary mixtures of alkaline and basic oxides (oxides of barium, manganese, titanium, calcium, magnesium, sodium and potassium) have been used as scavenging dopes for the elimination of sulphur from molten iron—sometimes added to the cupola charges and more often to the molten iron streams flowing from the cupola to the ladle. To give further fluidity to cupola slags, fluorspar is often added; this addition also assists the desulphurisation of the molten iron.

Probably the most successful method of eliminating sulphur and non-metallic oxides from molten iron is that developed by the Imperial Chemical Industries, Ltd. Their method consists of adding about 1 lb. soda-ash (Na_2CO_3) to 100 lb. of molten iron, the soda-ash being placed in the bottom of the ladle and the molten iron poured upon it. A strongly exothermic action occurs after the CO_2 of the soda-ash is expelled, non-metallic oxide particles in the metal forming a very fluid slag by combining with the soda, which also combines with the sulphur in the heavier sulphides of Mn and Fe to form sodium sulphide (Na_2S). The light sodium sulphide rapidly rises to the surface of the metal, being assisted by the rising bubbles of CO_2 . From the appearance of the metal surface after the reactions have subsided, it is clear that there has been further elimination of some of the gases normally present in the liquid iron. The overlying slag forming on the surface of the ladle is very fluid and is removed readily after ground limestone has been sprinkled over the top surface of the metal and rabbled until pasty lumps are formed which can be readily skimmed off.

A most important accompaniment of this soda-ash reaction is the effect on the final metal structure. The sulphide and non-metallic inclusions are largely carried off by the rising streams

of CO_2 gas, helped by the superheat caused by the burning of some of the sodium and sulphur at the metal surface, the soda-flame being vividly evident. The structure of the molten superheated iron is also affected by the agitation set up by the slag reactions and the gas escape and it is evident that the inter-molecular agitation at high temperatures continues until the metal has solidified in the moulds.

Use of Innoculants

Apart from the value of such desulphurisers as soda-ash, which encourage the ascent and escape of sulphides and non-metallic inclusions through the mass of molten iron in the ladle, the property of rendering harmless or innocuous the graphitic carbon liberated during the cooling and solidification of the metal is of vital importance. The first real innoculants were those developed by Goldschmidt of Essen under the name of "thermit" compounds which, when introduced into the bottom of a ladle of cast iron or steel promoted the escape of gaseous and non-metallic inclusions to the top of the molten metal mass, reduced segregation troubles, and led to sounder castings of higher tensile strength. In 1909 the same investigator exploited a calcium-silicon innoculant containing about 40 per cent. Ca and 60 per cent. Si, which has since been used largely as a cleanser and improver of cast iron, being applied like soda-ash as a ladle addition.

Whilst many scavenging, de-oxidising, de-sulphurising and innoculating agents have been used in the past for improving cast iron, their action has not been clearly understood, many failures due to wrong usage having thrown them into disuse. The requisite exothermic reaction and the production of thinly fluid slags, together with the sufficient temperature of superheat in the molten metal in which the innoculants function are details of fundamental importance to the foundry metallurgist. The British Cast Iron Research Association has for some time given close attention to this problem, with promising results. To obtain sounder and stronger castings the foundry cupola must yield suitably superheated iron, clean and free from gaseous and oxide inclusions. Such metal is then in a condition suitable for later treatment in the ladle by means of which the embrittling influence of badly distributed coarse graphite in the solid iron can be materially reduced and stronger, sounder and tougher castings can be regularly produced.

Tin Smelting and Refining Processes

Investigation of a New Method

EXCEPT in the case of the tin ores of Indo-China which often yield tin of 99.95 per cent. purity by smelting in a bloomery furnace at a comparatively low temperature, smelted tin must be subjected to one or more refining processes, so as to get rid of the copper, silver, arsenic, antimony, lead, iron, and tungsten. Attempts to obtain tin concentrates with a higher percentage of the metal from poor ores have recently been made, based upon the varying affinities to sulphur and oxygen of the common metallic impurities after reduction of concentrated tin ore. On the basis of Guertler's studies of the heats of formation of the sulphides and oxides, it is observed that whereas tin occupies an intermediate position in the sulphide-affinity series, its position in the oxide-affinity series is unusually strong and explains the comparative difficulty experienced in attempting to reduce tin peroxide.

The different position occupied by tin in the sulphide and oxide series, according to an article by W. Savelberg ("Metallbörse," June 25), may be exploited in different ways according to the amount of sulphur which it is decided to retain in the ore after the preliminary oxidation roast. If a large amount of copper is present, enough sulphur should be retained after roasting as to result in the formation of a copper matt which also carries with it the reduced iron. The other metals present, including tin, only dissolve up to a limited extent in the sulphide phase, and would therefore collect in the metallic phase. Assuming, on the other hand, that the proportions of antimony and lead exceeded that of copper, there would appear to be good prospects of the same amount of sulphur as was present in the first instance enabling tin

to be included in the matt, while the melted lead would carry along antimony, bismuth, silver and probably arsenic, leaving the tin contaminated only with copper and iron. A supplementary oxidation roast for the removal of a portion of the remaining sulphur, followed by smelting yields a fairly pure tin together with a copper matt.

Commencing with sulphide ores (which invariably contain tin as SnO_2) roasting may be continued until only enough sulphur remains as would suffice to combine with the copper present. Smelting is then carried out at a low temperature so as to yield a metallic phase containing lead, antimony, bismuth, silver and arsenic, while the un-reduced tin alone forms a slag. Although a remarkably thorough separation is secured in this case, the process is not economically feasible because of the difficulty with which the slag undergoes reduction. This method has been tested out on a Bolivian ore containing 22 per cent. tin (as SnO_2) in addition to 8 per cent. copper, 14 per cent. iron, 2 per cent. antimony and 1 per cent. silver. It was roasted until the original sulphur content of 14 per cent. (in the form of sulphides of the above metals) had been reduced to 5 per cent. On subsequent smelting, a copper matt separated out, followed by a metallic phase consisting chiefly of lead and silver with smaller quantities of tin and antimony. The copper matt had taken up the whole of the copper and varying amounts of tin, iron, antimony and silver. A fairly large amount of the tin, however, was converted to slag, while a further reduction in the sulphur content at the first stage resulted in the accumulation in the slag of by far the greater proportion of the tin.

The Lixiviation of Low Grade Copper Ores

Present Day Practice in Spain

THE direct leaching of low grade copper pyrites for the extraction of copper is carried out on a comparatively large scale in Spain. Pyrites which are unsuitable for sulphur recovery, due to excess of impurities of an undesirable nature, being present, but which contain a small percentage of copper, are treated directly by the leaching process. The result of this is that copper may be recovered whether the residual ore is fit or otherwise for sulphur extraction. Some pyrites, containing much schist, are quite unsuitable for sulphur burning on account of the large proportion of ash which they would leave in the furnaces of the sulphuric acid manufacturers. On the other hand, there are arsenical pyrites comparatively free from schist, which, due to the presence of the metalloid, are unsuitable for making the acid. Both of these types offer no obstacle to economical recovery of copper by the leaching process. In each case, after leaching, the residue is disposed of as waste. Pyrites which are free from impurities are treated similarly and the residual ore after leaching and drying in the air is shipped to the large sulphur burning combines. The ore heaps in some cases amount to as much as a million tons and more, and the process is consistent and continuous.

Constructing the Heaps

Present-day practice in Spain is largely in the hands of large copper companies such as Rio Tinto, Seville, and Tharsis. Although the process has been in use for some fifty years, the system of trimming and cutting vent shafts has been greatly improved during recent years. The object in making good vents is to ensure a steady draught passing continuously throughout the openings in the heaps to give the necessary oxidation. The heaps are made up of selected lumps according to a pre-arranged plan, since fine material (previously used) tends to cement together and prevent further percolating action. The larger lumps slowly disintegrate as the action proceeds, but it requires some considerable time to reduce the lumps to powder, and by that time practically all the copper has been removed. When the process

is first started, water is pumped up to the top of the heaps and allowed to trickle down to the bottom. In the hot climate with oxidising influences reacting strongly, the water is converted to dilute sulphuric acid, which dissolves the iron of the partially desulphurised pyrites, forming a dilute solution of ferric sulphate. The liquor accumulating at the bottom of the heap is continuously pumped up to the top and allowed to percolate through the mass, until the liquor has reached a comparatively concentrated condition.

Recovery of the Copper

The action of the ferric sulphate is to dissolve out the copper, forming a solution of ferric and cupric sulphates. This is led to large precipitating tanks and scrap iron is added, depositing the copper as a bulky red precipitate. Leaching is continued until on analysis the heap shows only 0.1 per cent. of copper, that is, on a basis of 1 to 1.5 per cent. copper, a 90 per cent. extraction has been made, which compares favourably with the best wet extraction practice. It is, however, necessary to prevent the acidity of the liquor reaching a high figure as this would unnecessarily dissolve a large amount of scrap iron in the precipitation of the copper. The latter reaction causes the iron to be converted to the ferrous condition. The ferrous liquor is allowed to lie exposed to the atmosphere for some time whereby it is more or less oxidised to the ferric condition, when it is pumped up to the heap top. The wet semi-oxidised pyrites are disposed to oxidise further on drying and the sulphurous acid formed oxidises jointly with the iron dissolved. Under these conditions the copper dissolves with ease and very completely, although otherwise under the influence of some adverse conditions. The use of pig iron for precipitating copper is now discontinued, and scrap iron only is used. The copper precipitate is washed and is well screened to remove pieces of scrap iron, and is then dried in kilns exposed on the surface to the atmosphere. Finally it is graded, sieved, packed in bags and sent into the market.

Electrolytic Zinc

A New Process of Manufacture

NEW data on the Sturbelle process of electrolytic zinc manufacture was revealed by the inventor at a recent meeting at Liège. This process was invented in Norway in 1916, and at the present time is being tried out at the Flanders Centrales Electriques, near Gand, Belgium. It is essentially different from the Tainton, Anaconda or Standard electrolytic processes.

The roasted blonde is treated with sulphuric acid solution containing about 60 grams of free acid per litre. This acid is produced in later stages of the process. The addition of zinc peroxide precipitates the iron, and the silicic acid is precipitated in the form of gel with the larger part of the antimony and arsenic—the two latter in the form of iron arsenates and antimonates. The greater part of the copper is precipitated and the mixture of slime passes into a thickener. The mixture is then drawn into a Sturbelle filter, where it is treated with acid solutions of successively higher concentrations which remove the zinc, even from ferrites, and the residue is thoroughly washed with water. At the end of this operation the cakes are removed. They are practically free of soluble zinc, but contain lead and the precious metals. During this process the copper, antimony, arsenic and iron redissolve and undergo electrolytic purification, which precipitates these impurities and even removes cobalt and nickel. This purified liquid is mixed in a drain with that part of the acid solution which is formed in the electrolysis tanks and which is not used in the filter. The mixture then re-travels the manufacturing cycle.

After being passed into a thickener, the clear wash is treated with zinc sulphide, either freshly precipitated or prepared directly by the addition of barium sulphide. During this operation all the impurities, especially cadmium,

are precipitated. The liquor and the sulphurous slime pass into a thickener where the slime when treated directly on a Sturbelle filter yields (a) a zinc solution which returns to the manufacturing process; (b) a pure cadmium solution which undergoes electrolysis; and (c) a slime which consists principally of sulphides of copper and tin. The clear filtrate goes to a filter press and from there feeds the individual vats.

When the liquor enters the vats it titrates 130 grams of zinc per litre. When it leaves, it contains 40 grams of zinc per litre and 135 grams of free acid. From the vats, the spent electrolytic passes, after cooling, into a drain, in which a pump replaces it in circulation through the vats and through the Sturbelle filter. The waste from the drain is mixed with the solution from which the copper is extracted; this mixture is returned to the cycle. The electrolytic yield is about 3,200 kilowatt-hours per ton of cathode, which gives 3,700 kilowatt-hours high tension per ton of zinc. The author estimates the operating cost at 1,000,000 Belgian francs per ton of zinc per day.

SLIGHTLY better results were obtained by the Lancashire Steel Corporation during the year ended December 31 last than in 1930, profits amounting to £53,307, against £47,937. As in the previous year, however, no provision has been made for depreciation. It is proposed to write off the balance of preliminary expenses, amounting to £23,779, and also the commission for guaranteeing subscription of 1,250,000 first preference shares of the corporation amounting to £31,250, which will leave a balance of £2,251 to be carried forward, compared with £3,913 brought in.

Acid-Dipping in Wire Manufacture

By RICHARD SAXTON

THE acids commonly used in wire manufacture are hydrochloric (muriatic), sulphuric and nitric. Hydrofluoric acid is used only in extreme cases, such as exist when the silica in the furnace tubes has attached itself to the wire. Whilst the majority of wire manufacturers in this country use muriatic acid as the principal cleaning medium, 90 per cent. of those engaged in this industry in the United States use sulphuric acid. Cost of steam may probably play a part in the British manufacturers' preference for muriatic acid, but given a fair trial, sulphuric acid will prove to be cheaper and quicker, and can be used for all qualities of wire. A further advantage is that there is little risk of acid rust, a big drawback in muriatic acid cleaning, and an evil which never fails to make itself apparent if washing has been insufficient, or drying-off too long prolonged.

Improved Use of Muriatic Acid

The present practice of immersing the material in the acid, and allowing the latter to remain at the same temperature as the surrounding atmosphere, is one which can be improved. The higher the temperature, the quicker the action, and if the use of steam to heat and agitate the liquor is impracticable, it can be agitated economically by compressed air, while the air ready heated, can be drawn from the drying ovens. Much cleaning liquor is run to waste in this cold working process while it has still strength to perform good service if heated, and in order to gain the fullest value, no liquor should be run to waste if it contains more than 1 per cent. of acid. The best muriatic acid mixture for cleaning wire and wire rods is one part of acid at 28/32° Tw. to two of water. Many manufacturers claim that to use this bath until exhausted, without the addition of further acid, is the most economical, but careful tests prove otherwise, for if scale is removed at fairly short periods, a bath freshened up with new acid not only gives better results, but a greater percentage of material cleaned. The material cleaned in a bath of this description will also draw much better than that which has been cleaned in one in which the acid has not been revived. Many users also contend that the scale lying at the bottom of the tank is a deterrent to adding new acid, as it has a tendency to lower the strength, but this opinion is untenable, as the scale is practically insoluble in this acid mixture.

The action of the acid upon the material is rather interesting. The scale, being porous, allows the liquor to percolate through to the metal, with which it evolves hydrogen. This gas, as it expands, actually loosens and forces away the scale. After the material has been allowed sufficient time to clean, it is washed to remove loose scale, and then dipped into a bath of milk of lime to neutralise any acid which remains. From here it is taken to the drying ovens. The heat applied in the drying ovens also serves the purpose of driving off further acid which the milk of lime has failed to remove, in cases where acid has penetrated into the pores of the metal.

Comparison With Sulphuric Acid

The process of cleaning with sulphuric acid is similar to that using muriatic acid, with the exception that it is essential that the liquor be heated before efficient action can take place. A bath made up of 5 per cent. sulphuric acid, and working at a temperature of between 70° and 90° C., is the best mixture for wire cleaning. It is necessary to keep the temperature of this solution as nearly constant as is possible, and a temperature recording instrument is a useful addition to the plant. The acid strength should also be kept as constant as possible. If the dipping department is well able to cope with the demands of the drawing mill and time can be spared for longer immersions, a 2 per cent. acid solution, with increased temperature, will produce material that will draw much easier. The action of the sulphuric acid bath is somewhat similar to that of the muriatic acid bath, but the scale is converted into ferrous sulphate. Unlike muriatic, there is therefore a point where the addition of further acid is merely wasted, due to the accumulation of ferrous sulphate, and at this point the

liquor should be run off and the tank cleaned out. Where wet drawing is part of the manufacturing process it is usual to recover this ferrous sulphate. For this purpose the spent liquor should be run off into a spare tank and concentrated by steam heat until it reaches a specific gravity of 75° Tw. In the cooling process the ferrous sulphate will crystallise out, and the remaining liquor can be used in making-up a fresh bath.

Nitric acid is rarely used in the cleaning of common steel wire, the high cost as compared with that of muriatic and sulphuric acids being the deterring factor. It has, however, come much to the front as a cleaning medium for stainless steels, especially in conjunction with sulphuric acid. Many experiments have been conducted in the endeavour to evolve a simpler method of cleaning stainless steels, but the present system of first immersing in a 5 per cent. hot sulphuric bath, followed by a 15 to 20 per cent. cold nitric bath, still remains the most effective. An alternative method of cleaning stainless steels is to use a mixture of 15 to 20 per cent. muriatic acid and 5 per cent. nitric acid. This liquor is used in a cold condition, but care has to be exercised, as the hydrochloric acid attacks the material much more keenly than sulphuric acid does.

Restrainers or Inhibitors

During the past few years there have appeared upon the market a number of products termed *restrainers* or *inhibitors*, the purpose of which is to restrain the action of the acid on exposed metal while other parts are being treated to remove scale which is proving more difficult to dislodge. Various claims have been made for these products, particularly in eliminating acid brittleness in high carbon steels, but the majority of wire manufacturers still stand aloof from adopting them. The assertion that they keep the atmosphere of the department more free from fumes is undoubtedly true, but the same purpose could easily be achieved by using a half-strength solution of cleaning liquor. In a well-ventilated acid-dipping department there should be little complaint of fumes, except on windless days, when even restrainers will have little effect in preventing fumes.

In comparing muriatic, sulphuric and nitric acids as wire cleaners, it may be stated that the climate of Great Britain is a big factor in the successful cold working of muriatic acid, yet more pronounced advantages could be gained if this acid is worked in a heated state. The disadvantage asserted, that by running steam into the liquor the latter is weakened, is not borne out by actual working conditions. In one way the steam certainly does weaken the liquor, but at the same time the steam heat continually drives off moisture, thus tending to concentrate the liquor again. Allowing for weakening by the attack of the acid on the metal, it is found that there is practically little waste. Sulphuric acid, however, is undoubtedly the best wire cleaning medium. It is quicker, and there is little cause to fear trouble in the finished wire from acid rust. The necessary use of steam as a heating medium is added expense as against the cold working or muriatic acid, but cost for cost, less sulphuric is needed to clean an equal amount of material.

Nickel Alloys for Steam Valves

In the course of recent investigations on nickel-copper-tin alloys suitable for use in steam valves ("Comptes rendus," 1932, p. 2102) it was observed that the presence of small amounts of silicon had a very important effect on mechanical properties. A systematic study was therefore made of the properties of nickel-copper-tin alloys containing up to 5 per cent. of silicon, with nickel 50 to 70 per cent. and varying percentages of copper and tin. Examinations of the structure, hardness and physical properties of the alloys indicate that the silicon additions have a markedly beneficial effect; the compositions (a) nickel 50, copper 39, tin 8, silicon 3, per cent. and (b) nickel 65, copper 27.5, tin 4, silicon 3.5, per cent., appear specially promising.

Some Recent Metallurgical Patents

Nitrogenising Iron

IN a process for nitrogenising iron steel and alloys thereof, the metal is heated in the presence of a gaseous nitrogenising agent and one or more oxides of nitrogen such as nitric oxide. The nitrogen oxide may be produced in situ by the employment of a suitable reagent such as lead nitrate. In an example, the gaseous atmosphere consists of 4 parts by volume of ammonia and 6 parts of nitric oxide. Alloys are referred to containing specified proportions of manganese and chromium, aluminium and molybdenum and vanadium. (See Specification No. 373,284, Electro Metallurgical Co.)

Refining Iron and Steel

MOLTEN iron or steel is degassed and deoxidised by heating the metal in an induction furnace to a temperature of 250° C. in excess of the melting point of the metal and in the presence of a slag having a low melting point and high viscosity. The slag excludes atmospheric air from the molten metal and may consist of 1-50 per cent. of glass, 1-20 of iron oxide, 1-5 of flourspar and the balance lime. The slag may be used in the melting of the charge and then removed and replaced by a fresh slag during the heating up to the desired temperature. (See Specification No. 373,295, Hirsch, Kupfer- und Messing-Werke, A.G.)

Steel Alloys for Welding Rods

CHROMIUM nickel steel alloys for use as welding rods in welding ingot iron, grey cast iron, cast steel, cast silicon steel and structural steel contain from 10-30 per cent. of chromium and 2-30 per cent. of nickel, preferably 25 per cent. of chromium, 20 per cent. of nickel and 0.15 per cent. of carbon. The alloy may also contain tungsten, molybdenum, titanium, vanadium and beryllium. Such alloys may contain 18 per cent. of chromium and 8 per cent. of nickel together with either 4 per cent. of molybdenum and 0.15 per cent. of carbon, or 0.6 per cent. of titanium and 0.12 per cent. of carbon, or may contain 18 per cent. of chromium, 10 per cent. of nickel, 0.8 per cent. of tungsten and 0.1 per cent. of carbon. (See Specification No. 372,678, F. Krupp, A.G.)

Magnetic Alloys

MAGNETIC iron alloys containing 40-50 per cent. of nickel are made by melting the ingredients in an open hearth or induction furnace and in an atmosphere free from nitrogen, e.g., hydrogen or a vacuum, and rolling the resultant alloy into sheets. The sheets are then annealed in a non-oxidising atmosphere at 900°-1,100° C., cooled down to 600° C. at a rate varying from 20° to 100° per minute and then cooled slowly in air to room temperature. The alloy is rolled at an elevated temperature into a sheet about 14 mils. thick, the temperature of the sheet being between 600° and 700° C. during the finishing pass through the mill. Up to 3 per cent. of manganese and silicon may be incorporated in the alloy. Hydrogen which is dry and free from oxygen may be used as the non-oxidising gas during annealing. (See Specification No. 371,205, British Thomson-Houston Co., Ltd.)

Extraction of Nickel and Copper

A STRONG reactive metallic nickel product, obtained by gas reduction, for example with hydrogen or water gas, of nickel compounds at low temperature, preferably from 350° to 450° C., is used to neutralise the acidity and to cement the copper present in nickel salt solutions below 60° C. from which iron is subsequently removed by oxidation with air. In an application of the process, nickel-copper matte is ground, roasted to remove sulphur and leached with acid for the partial removal of copper. Part of the leached residue is reduced under the specified conditions to obtain a nickeliferous metallic powder. The remainder is converted to metal and cast into anodes for purification in an electrolytic cell. The electrolyte is purified employing the nickeliferous powder obtained as above. The exhausted nickeliferous material is mixed with the ground matte and re-used. (See Specification No. 372,958, Falconbridge Nickelverke Aktieselskap.)

Castable Hard Alloys

CASTABLE hard alloys containing carbides of metals or non-metals are made by using as starting material carbon-containing iron alloys such as ferro-molybdenum, ferrotungsten, ferro-chromium, or iron-boron, with additions of metals such as tungsten, chromium, cobalt, or molybdenum, or of alloys containing boron or silicon, or of tungstic acid, or of molybdenum alloyed with cobalt or chromium. Iron alloys containing respectively 80 per cent. of tungsten carbide, 90 per cent. of tungsten chromium double carbide, and 87 per cent. of chromium carbide, are referred to. (See Specification No. 373,113, Imperial Chemical Industries, Ltd.)

Distilling Zinc

IN an application of a process for removal of chlorine from solutions containing zinc chloride, zinc-containing alloys, as brass, admixed with coal and if desired with zinciferous ores, are treated in a blast furnace. The evolved fume is collected, and the residue admixed with a large quantity of alloy and blown. Copper obtained from the converter passes to electrolytic refining operations. The fumes from this and the previous operation, containing zinc, zinc oxide and sulphate, lead oxide, copper oxide, copper, tin and silver are dissolved in sulphuric acid, and treated for the removal of chlorine. (See Specification No. 370,965, Nichols Copper Co.)

Aluminium Alloys

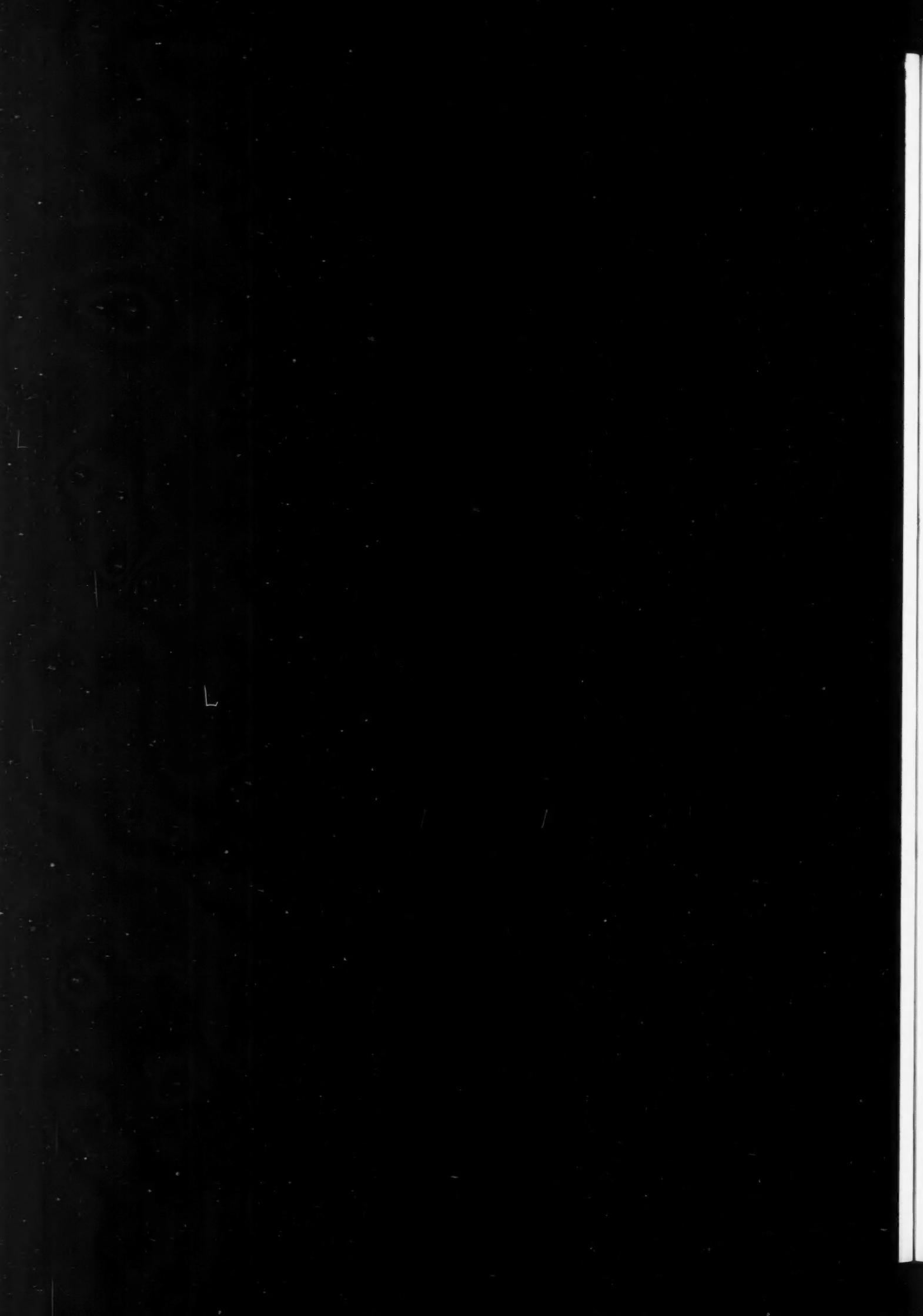
AN aluminium alloy contains 0.3-0.5 per cent. of chromium, 0.5-7.0 per cent. of magnesium and 0.3-4.0 per cent. of iron. In making the alloy an aluminium alloy containing a combined proportion of 25 per cent. of iron and chromium is added to molten aluminium. The crucible is removed from the furnace and the magnesium is added while stirring vigorously with an iron rod. The alloy may be annealed at 300°-400° C. Alloys containing specified proportions of (1) aluminium and silicon, (2) aluminium, copper, nickel and magnesium, (3) aluminium, copper and zinc, (4) aluminium, magnesium, manganese and antimony, (5) aluminium and magnesium, and (6) aluminium and copper, are also referred to. (See Specification No. 370,970, I. Iyata and M. Z. K. Kaisha.)

Heat Treatment of Alloy Steels

ALLOY steels containing a precipitation hardening element, e.g., Cu Ti B Zr during cooling from a high temperature, e.g., the working temperature (200°-800° C.) to increase the hardness and strength by precipitation hardening. In the case of copper alloy, the alloy is allowed to cool from its production temperature to 500° C. and then maintained at 500° C. for a few hours. The parts may be fed in on a conveyor to the cooling bed with insulated bottom and heat protecting hood. After hardening rapid cooling by air, steam or water may be used. A steel containing 0.17 per cent. C, 0.38 per cent. Si, 1.2 per cent. Mn, and 0.75 per cent. C. was slowly cooled from the rolling temperature down to 450° and kept there for 20 hours and was then quickly cooled to hand temperature. (See Specification No. 373,017, F. Krupp, A.G. Friedrich-Alfred-Hütte.)

Refining Metals

IN a method of refining metals, a layer of refining materials which will melt at a temperature below the melting temperature of the metal to be refined is introduced into the bottom of the furnace and the metal to be refined is fed into the furnace on the top of the refining layer. The charge is then heated from above the refining material and the latter melts and forms a liquid layer at the bottom of the furnace, the metal as it melts descending through the refining layer and being thereby purified. The refining materials contain sodium, potassium or barium hydroxides, singly or in combination, calcium carbide or calcite and carbon in any of its solid forms except graphite. The metals treated may be iron, steel, zinc, copper, aluminium or lead. When treating copper or aluminium, the refining materials comprise sodium carbonate or potassium hydroxide and silica. (See Specification No. 372,326, J. W. Flannery.)



Metallurgical Section

October 1, 1932.

A Bright Future Predicted for Beryllium Bronzes

THE light alloys of beryllium with aluminium have been especially investigated in America. In the liquid phase the two metals mix in all proportions; in the solid phase, beryllium takes up some aluminium (about 8 per cent.) in solid solution. The melting-point of aluminium is lowered but little by the addition of beryllium, since the composition of the eutectic lies at only 1.4 per cent. of beryllium. Upon further additions of beryllium, the temperature at which solidification takes place begins to rise very rapidly until with a beryllium content of 8 per cent. it reaches 1,000°C. There is little difficulty in preparing such beryllium-aluminium alloy castings of almost any composition. It is also possible to secure flawless rolled sheets (down to thickness of 0.1 mm.) from cast alloys containing beryllium up to 75 per cent., which is the highest percentage yet investigated. The rolling is either done cold, with occasional annealing at 600°C., or hot at 600° to 650°C. Efforts to alloy beryllium with magnesium have been unsuccessful, because at temperatures below its own melting point beryllium does not dissolve in liquid magnesium. On the other hand, it is not possible to heat the two metals up to the melting point of beryllium because the magnesium boils before that temperature is reached.

When heavy metals such as copper are alloyed with a small percentage of beryllium, surprising results as to temper and hardness are obtained. Siemens and Halske have explored this field with great thoroughness, employing all modern methods of the metallurgist, and many commercial applications have been developed. This is especially true of the beryllium-copper alloys. Alloys of beryllium with copper and other heavy metals are produced electrolytically by adding the finely divided alloying metal to a fused beryllium oxy-fluoride bath. The added metal then melts, sinks to the bottom of the crucible (which serves as anode), is converted into the fluoride and dissolved in the melt and finally migrates with the beryllium to the cathode, where the alloy separates out. This procedure is especially applicable to beryllium-rich alloys. To produce alloys of low beryllium content, the metal to be alloyed is used as the cathode, for example, a cathode of molten copper dissolves the electrolytically deposited beryllium.

Resistance to corrosion in the case of the beryllium-bronzes is about equal that of the tin or aluminium bronzes. The beryllium bronzes cast easily and are readily cold-worked. They can also be hardened by a suitable heat treatment. When 2 to 3 per cent. of beryllium is added copper, the hardness is increased five-fold, i.e. from 100 up to 400 or 500 Brinell; the limit of ductility is increased seven-fold; the breaking

and the bending limits, three fold. A copper alloy with 6 to 7 per cent. of beryllium has a Brinell hardness of 750, corresponding to that of the hardest steel. As compared with other bronzes, beryllium bronzes show the highest electrical conductivity, and they are easier to shape. Their greater hardness and strength permit them to be used for structural members that are subject to severe strain. In many cases a decided saving in weight and cross section is brought about, and a bright commercial future is to be predicted for such bronzes. They are already used for springs which possess peculiar mechanical and chemical resistance, and show very slight fatigue phenomena. Leaf springs of this type have endured 10,000,000 bends without breaking. Phosphor-bronze leaf springs, on the other hand, when submitted to the same test, failed after about 400,000 bends; or under the most favourable conditions at 1,000,000 bends. In the case of electric locomotives, the uninterrupted jarring causes brush-holders and contact-caps to last only a few weeks when they are made of a beryllium-free bronze. The use of beryllium bronzes, however, eliminates this continual necessity for the renewal of the parts in question.

The high resistance of these bronzes to corrosion and erosion renders them especially suitable for pumps, liquid meters, and turbine blades. They may be substituted with distinct advantage in all cases where aluminium phosphor-bronzes have been employed and have developed noticeable weakness. In contrast with castings of aluminium bronzes, those of beryllium bronze show complete freedom from oxides, a greater density, and a greater strength at higher temperatures, which is often an important property. Alloys of beryllium with nickel or cobalt, as well as the three-metals systems, beryllium-copper-nickel, beryllium-copper-zinc, and beryllium-copper-aluminium, also possess useful properties. Alloys of iron, chromium, nickel and beryllium show not only a chemical resistivity corresponding to that of V2A-steel (18 per cent. chromium 8 per cent. nickel), but excellent hardness, strength and elasticity. It has been found possible to produce beryllium steels, without adding carbon, that have an appreciable residual magnetism. When the binary beryllium steels are annealed, they resemble silicon steel. Iron alloys, composed of 12 per cent. chromium, 5 per cent. nickel, and 1 per cent. beryllium, attain the temper of high-speed steel after ageing. An alloy of 20 per cent. chromium, 7 per cent. nickel and 1 per cent. beryllium behaves like a temperable V2A-steel, while an alloy of 36 per cent. nickel with 1 per cent. beryllium resembles the invar steels, combining good resistance to atmospheric corrosion with very considerable strength after tempering.

The Metal Markets

THAT the ramp in copper was the direct outcome of the share boom in New York has been amply proved by the fact that the collapse of value on Wall Street has been reflected in a heavy fall in the quotation for standard copper. When the landslide in the American stock markets was at its height the price of standard copper in London broke £4 10s. in one day's trading, and though buyers came to the rescue and helped to recover some of the loss the tendency since has been nervous and erratic, more particularly as copper values in the United States are not any too strong. The fact of the matter is that the rise in copper values went well beyond the point justified by the improvement in consumptive demand, which has certainly given some indications of looking up, but has never been sufficient to justify a rise of £12 in the price of the red metal. For the moment the London market is still being influenced by the tendency on Wall Street, and a good deal of day-to-day alteration may be expected. In spite of the proviso regarding sales at "world price" it is impossible to believe that in the future British consumers of copper are going to obtain their raw material at such an advantageous figure as Continental buyers, and the chances are that much of our export business will be sacrificed accordingly. In the meanwhile consumers in this country are buying cautiously on a hand-to-mouth basis, and are naturally sticking to Empire brands, even though the price may compare unfavourably sometimes with that at which foreign copper is offered. The rise in tin was just as much overdone as the rise in copper, and the recent collapse which brought the quotation down by £10 did not come as a surprise. The ramp in tin, with the price in the neighbourhood of £160 per ton, has been as obvious as in any of the metals. During the past few weeks buying has certainly registered an improvement, particularly in the United States, but whether this increase in activity is due to the receipt of more orders by the tinplate works and other users of the metal, or whether it is, as seems very probable, with a view to the replenishment of stocks which have been allowed to fall too low, remains to be seen. Both lead and spelter have suffered a decline as the result of the sudden change in sentiment in regard to commodity values, but some recovery from the lowest points reached has occurred. Buying, especially of lead, is on a broader scale than it was.

Metallic Moulding Powders

THE manufacture of small objects moulded from powdered metal is forming the basis of a new industry for the manufacture of metal parts which would otherwise be cast or drop-forged. The process was originally an off-shoot of the manufacture of tungsten wire for electric light filaments, and the technique followed is similar to that used in the moulding of synthetic resin powders, such as bakelite. In addition to tungsten, iron, chromium, nickel, and copper, and various alloys are now being moulded. The metallic moulding powder is produced by electrolysing a solution of a corresponding metallic salt, so that a spongy layer of pure metal is deposited at the cathode. This sponge is then removed, freed from traces of the metallic salt, dried and pulverised and finally sifted to form a powder of definite particle size. A predetermined

amount of the powder is placed in a steel mould and subjected to a pressure in excess of 5,000 lb. per square inch by means of a hydraulic press. The formed article is then heated to cause sintering. The finished article is essentially a metallic sponge, varying in density from one-third to four-fifths of the theoretical density of the pure metal, according to the grade of powder used, the pressure, the number of times it is pressed and heated, and subsequent working. It may be put through any of the common operations carried out on cast ingots. Heat treatment consists in heating the article in a reducing atmosphere to a temperature somewhat below the melting point of the metal and maintaining the temperature long enough to cause sintering and also to cause the diffusion of the metal in the case of an alloy. The advantages of this technique are to be found in the control of density, composition and shape of the fabricated part. Alloys which it is impossible to produce by conventional methods, because the component metals are immiscible in the liquid state, or because the difference in their melting points is too great, may be produced by using these moulding powder mixed in the proper proportions.

Zirconium in Steel Manufacture

SEVERAL hundred tons of zirconium ore are used annually in the production of zirconium alloys. These alloys, which are produced in electric furnaces, are employed principally in the production of steel castings. The substitution of zirconium-ferrosilicon for the ordinary ferrosilicon makes possible a sounder and cleaner product, which is desirable in castings, forged products, and rolled shapes subjected to repeated and violent shocks. Silicon-zirconium is preferred for removing objectionable gases and non-metallic impurities in the finer alloy steels. Until very recently the claim was made that zirconium did not alloy with iron, but now ferro-zirconium, zirconium-ferro-silicon, and silicon-zirconium are on the market and are recommended for use in steel, as well as in nickel alloys. When added to steel, zirconium performs three important functions. By its powerful de oxidising action it vigorously reduces metallic oxides and scavenges non-metallic inclusions, but it does not tend to remain in the steel in the form of an oxide, as in the case of aluminium. By reason of the cleansing which it receives, the steel becomes homogeneous both as to composition and structure. Secondly, zirconium combines chemically with nitrogen which is dissolved in the steel, forming a nitride, the greater part of which enters the slag; the few nitride crystals remaining in the steel are too minute to have any effect on its mechanical properties. Finally, zirconium combines chemically with sulphur abstracted from the iron, the resulting sulphide being malleable like that of manganese. Moreover, the hot-shortness of high-sulphur steel can be diminished through the agency of zirconium to a degree not attainable by manganese, but for economic reasons it is not suggested that zirconium should displace manganese entirely in the treatment of high-sulphur steels. A zirconium-treated carbon steel is characterised by freedom from inclusions, which would act as nuclei for shock and fatigue failures; uniformity of grain, which assists in the effectiveness of heat treatment; excellent hot-working properties; and tensile properties closely approaching those of special alloy steels.

Researches on the Preparation of Pure Beryllium

Variation of Conditions for Electrolysis and Sublimation

Details of research on the preparation of pure beryllium at the National Physical Laboratory are described in this article, which is abstracted from a paper by H. A. Sloman, presented at the recent meeting of the Institute of Metals.

THE objects of the work on beryllium which has been in progress, in the Metallurgy Department of the National Physical Laboratory, for the Minor Metals Committee of the Metallurgy Research Board, Department of Scientific and Industrial Research, may be broadly divided into two sections. Firstly, the preparation of the metal in a pure, compact form, and secondly, an investigation of the constitution and properties of beryllium alloys. The research on beryllium was commenced in 1923, partly at the suggestion of the then Superintendent, Dr. W. Rosenhain, F.R.S., whose attention had been called to the possibilities which might reside in some of the lesser known metals, by his participation in the work.

It was at the request of the Minor Metals Committee of the Imperial Mineral Resources Bureau that the Department of Scientific and Industrial Research set up a "Minor Metals Research Committee," under Dr. Rosenhain and his collaborator, then Dr. A. C. Vivian, commenced the study of beryllium. This metal was chosen for investigation because what was known about it suggested that it might have important possibilities in combining strength and lightness, and the problem before the investigators in the first place was that of producing beryllium metal. Up to a certain point that problem was quickly solved by the work of Dr. Vivian, who by 1926 had succeeded in producing solid electro-deposits by the fusion electrolysis of an electrolyte consisting mainly of beryllium and sodium fluorides, when the degree of purity achieved was approximately 99.5 per cent. From the present point of view the most important fact is that metal of this degree of purity was entirely non-ductile, and it was realised that the production of beryllium of high purity presented problems of an entirely different order from those which had been overcome in the preparation of the metal having the degree of purity indicated above. Dr. Rosenhain, however, strongly maintained that if the metal could be prepared in a sufficiently high state of purity it should possess valuable properties differing materially from those of the impure substance, for the fact that the metal possesses a close-packed hexagonal crystal lattice suggests that it should be reasonably ductile, and that the hardness and brittleness observed in the samples so far prepared must be due to impurities.

The present investigation commenced with the publication at the end of 1926 of Dr. Vivian's paper in which was described the method evolved at the National Physical Laboratory for the electrolytic production of beryllium. This paper ("Trans. Faraday Soc.," 1926, 12, 211) pointed out that the metal produced was contaminated by small amounts of iron, carbon, silicon, aluminium, and nitrogen, present in decreasing quantities in the order named, giving beryllium content of more than 99 per cent. A study of the source of the above elements was then made. It was found that the Acheson graphite was responsible for the carbon and part of the iron and silicon, whilst the beryllium carbonate or oxide purchased from various sources, and used as the starting point in the preparation of beryllium fluoride, was responsible for the aluminium and the remainder of the iron and silicon. The method of purifying the graphite from iron and silicon was described, and it was further shown that on remelting the metal, most of the beryllium carbide segregated, by reason of its greater density, to the bottom of the ingot, and could thus be removed by sawing off that portion. This metal, however, was brittle, fractured very readily, could not be worked, and had a Brinell hardness of about 140 to 160. The melting point was given as about 1,280° C.

Improved Technique in Electrolysis

Subsequent attempts to prepare pure beryllium first involved a complete study of the technique of the actual electrolysis, chiefly with the object of increasing the length of time during which deposition was continuously possible. In the earlier work, the limit was about 7 to 8 hours, after which the bath became increasingly high in resistance, whilst disintegration of the auxiliary graphite anode plates occurred.

The latter trouble was caused by the burning of the graphite above the level of the melt in that region where the temperature was about 800° to 1,000° C. The method of protection described in the earlier paper was to evacuate the air from the pores of the graphite under concentrated sodium chloride solution, and allow them to become filled with the salt. After careful drying, a surface glaze was then produced by immersion in fused sodium chloride.

Concurrently with this improved technique, increased purity of the cathode metal was attained. In 1929, British Patent No. 312,007 was obtained covering a method for the production of pure beryllium oxide from beryl and other sources. The use for the electrolysis, of beryllium fluoride prepared from oxide produced by this method, together with a much more careful purification of the graphite parts of the electrolytic furnace, immediately lowered the percentages of certain impurities, so that it now became possible consistently to obtain metal which after remelting to segregate the major portion of the beryllium carbide, contained beryllium (99.7 to 99.8 per cent.), iron (0.01 per cent.), carbon (0.05 per cent.), and silicon and aluminium (trace). All further attempts to improve the purity beyond this point were unsuccessful, and it became obvious that some subsequent treatment would be necessary to obtain pure metal. Moreover, the properties of these more recent deposits were not very different from those produced much earlier, the chief change being a fall in Brinell hardness from 140-160 to 100-120. This drop in hardness was found to follow the decrease in the iron content. The metal was still very brittle, and to obtain it quite pure became of increasing importance, in order to determine whether beryllium itself was essentially a brittle metal or whether this undesirable property was due to one or more of the very small amounts of residual impurities.

Attempts to Prepare Oxygen-Free Beryllium

The access of air to the molten beryllium during its electrolytic preparation probably accounts for practically all the oxide subsequently found in the metal. If, therefore, the conditions could be suitably varied, oxygen-free metal might be produced in the first stage. An inert or reducing atmosphere was called for, and of the gases available, carbon dioxide seemed the most promising. Nitrogen was avoided on account of the ready formation of nitride when beryllium is heated in it; hydrogen offered possibilities if the danger of explosion could be definitely overcome, whilst argon was considered too expensive. Carbon dioxide was therefore selected, but this was not ideal, owing to the risk of reduction to the monoxide by the balanced reaction $\text{Be} + \text{CO}_2 \rightleftharpoons \text{BeO} + \text{CO}$.

A preliminary investigation by heating beryllium almost to the melting point in pure carbon dioxide, showed that up to that temperature, at any rate, the risk was very small. Several depositions were, therefore, carried out using a stream of carbon dioxide over the surface of the melt. As had been feared, the electrolysis could not be conducted for any appreciable time, owing to the gradual accumulation of graphite scum, which bridged the electrodes and became entangled in the solidifying metal. This scum is normally burnt away in air. The substitution by other materials of all or most of the graphite offered possibilities, and a large number of trials with different refractory materials was carried out, but none was found which would withstand fluorine attack. Heat-resistant "stainless" steels were examined, but while they did not actually break up, contamination of the melt by iron fluoride was serious at the temperatures involved. Attempts to alter the existing technique were, therefore, discontinued.

Some attention had been given to the deposition of beryllium from fused electrolytes at relatively low temperatures, but with no very marked success. With the failure of the above attempts to produce oxygen-free metal, this type of experiment again came under consideration, and a large amount of work has been carried out on these lines. It was realised that the difficulties inherent in methods employing temperatures above the melting point of beryllium would be

much simplified here, and many might disappear completely. The electrolyte, for instance, must have a low melting point so that at about 600° C. it shall be reasonably fluid and have a high conductivity. At the same time, serious volatility is very undesirable. Of the compounds containing the beryllium cation, the fluoride is again the only one that can be employed, but as it is a non-conductor in the fluid state, sodium fluoride is added. A mixture of sodium fluoride with twice its weight of beryllium fluoride was found to possess very satisfactory properties. Even below 600° C. it is sufficiently fluid to electrolyse.

Alteration of Electrolytic Conditions

In the first trials, a mixture of this composition contained in a graphite or nickel crucible, heated externally to 650° to 700° C. in an electric furnace, was electrolysed using a copper rod as cathode and graphite as anode, with a current density at the former of 0.5 amp. per sq. cm. at 3 volts. After electrolysis for one hour, the cathode was removed. The superficial fluoride crust which is readily soluble in water was dissolved off, exposing a definite film of steel-grey beryllium. Further experiments were then performed with the object of obtaining thicker deposits. The first variable to be altered was the duration of the electrolysis, but it soon became apparent that if this was continued for more than about 1.5 hours, the resistance of the bath gradually increased, and at the end of 2 hours it behaved almost as a non-conductor.

The possibility of the formation of a high-resistance film around the anode or cathode or both was next investigated. Beryllium was substituted for graphite as anode, but showed no advantages. A rotating anode of graphite was then tried, with excellent results. The resistance remained constant over several hours, as was also the case when the rotating anode consisted of beryllium. It seems certain, therefore, that the increase in resistance is a function not of the anode material itself, but of the anode-bath interface. Several experiments were conducted with a rotating graphite anode, other conditions such as temperature, current density, etc., being as above. The electrolysis went very smoothly, but the resulting deposits could not be obtained thicker than about 0.01 in., however long the experiment was continued. The only difference between the results of one lasting one hour and another lasting five hours was that in the latter case the extent of diffusion and the percentage of beryllium in the intermediate alloy layer were considerably greater. Further experiments were then conducted in an attempt to find operating conditions which would obviate the non-adherent coarsely crystalline nature of the thicker deposits.

Sublimation of Beryllium

Sublimation or distillation *in vacuo* has been used at the National Physical Laboratory with success for the purification of several metals, and its earliest application to beryllium was described in the previous publication. An ingot of the metal is placed in a small refractory crucible, suitably lagged, on which a similar crucible stands inverted, with a small hole in its base for sighting purposes. These are contained in a vertical silica tube completely closed at the base with a rubber stopper. At the top is another stopper fitted with a small brass tube closed with a glass window, and a second, larger tube, for evacuating the apparatus. The most suitable method of heating is the high-frequency induction furnace, in which the metal itself acts as the heating element, and is thus the hottest part of the system, whilst the silica tube is comparatively cold, being watercooled on the outside by a helical copper tube which itself forms the induction coil of the furnace. A good vacuum can thus be readily maintained, although the metal may be in the neighbourhood of $2,000^{\circ}$ C. Moreover, the inverted refractory crucible or hood is heated only by radiation from the small ingot of metal, and remains well below the metal in temperature, thus forming a condensing surface for metal vapour. In the case of beryllium, both the containing crucible and the hood are made of pure beryllium oxide.

The earlier trials were carried out with the beryllium at a temperature of about $1,750^{\circ}$ to $1,800^{\circ}$ C. and a pressure of 0.1 to 0.05 mm. A considerable quantity of material was collected in the hood, chiefly in the form of globules and thin films adhering to the walls. Some of the globules were large

enough to examine. Analysis showed the composition to be very similar to that of ordinary remelted metal, except that carbide was very rare. The Brinell hardness was irregular, being 110 to 120 (as found for the purest remelted metal) in some globules and as low as 90 in others, but the material was still brittle to a varying degree.

Sublimed Metal of 99.9 per cent. Purity

In view of the impracticability of improving the conditions, it was decided to continue a sublimation experiment for many hours in the hope that the amount of sublimate produced would be sufficient for examination. At the end of about six to seven hours the material in the hood was examined. A few splashes were present, together with a thin cylinder of bright crystalline metal about 1 mm. thick. The surface in contact with the silica was smooth, the other being ragged, representing uneven growth from many centres, of the condensed metal vapour. This metal was very different in properties from that previously prepared by any other method. The beryllium content was directly estimated at more than 99.9 per cent. The Brinell hardness number was much more uniform over different parts of the specimen and ranged from 60 to 65.

Many further attempts were made to prepare larger quantities of sublimed metal, but up to the time when this part of the work was discontinued, it had not been possible to prepare specimens suitable for mechanical tests. It seems, however, that the essential ductility of beryllium has been established by these experiments on the production of sublimed metal of the above purity. The Brinell hardness of this metal, as stated above, is about 60 (slightly higher than that of pure iron), and it is not likely that any further increase in purity would lower this figure appreciably. Whilst beryllium, therefore, is not so soft a metal as copper or silver, it is ductile in a pure form, and likely to be similar to, say, iron in mechanical properties.

Attempts to Deoxidise Beryllium

The affinity of beryllium for oxygen, both above and below its melting point, is such that it appeared very doubtful if any of the usual deoxidisers would be capable of reducing the residual oxide. Serious attention was, however, given to the use of hydrogen in this connection. The gas was circulated in a closed system over molten beryllium, contained in a beryllia crucible and heated in a high-frequency induction furnace. Within the system were incorporated water vapour and oxygen absorbers and freezing mixtures (carbon dioxide and acetone), together with a means for keeping the gas circulating. The results of many experiments with different pressure of hydrogen ranging from a few centimetres to 1 atmosphere were to show that no appreciable reduction in the oxide content of the beryllium was obtained. The only difference between melting the metal in an atmosphere of hydrogen *in vacuo* was the much cleaner upper surface of the ingot in the first case on solidification. The ingot was not unsound owing to expulsion of hydrogen on solidifying. It was concluded that hydrogen either does not reduce beryllium oxide dissolved in molten beryllium, or that it was not in sufficiently intimate contact with the interior of the molten metal under the above conditions.

A more drastic method was tried, which involved the use of an atomic hydrogen blow-pipe, in which an arc is struck between two tungsten electrodes held at about 30° to one another, along which a strong stream of hydrogen is forced. The part of the gas surrounding the arc is atomised, whilst the remainder burns, giving a large space occupied by a reducing atmosphere outside the intensely hot central atomised portion. Some preliminary trials were made with copper containing a known percentage of oxygen. The metal, held in a small crucible, was melted by direct application of the arc from above. After being liquid for about two minutes, the metal was cast into a small mould, being kept all the time within the area of the hydrogen flames until completely solid. It was found that by once melting in this way, the oxygen content could be reduced from 1 per cent. to 0.03 per cent. A disadvantage of the method lay in the porosity of the resulting ingot due to hydrogen gassing. The results, however, were of sufficient promise to warrant similar experiments with beryllium, but with this metal no increase in purity was obtained.

Silver Extraction by Electrolysis

Present Day Practice

THE Moebius plant for the electrolysis of silver was originally introduced some twenty-five years ago. Due to the development of several similar systems at about the same period, it did not immediately come in for the recognition which, under other circumstances, it would have received. The complexity of the plant gave rise to numerous working difficulties, particularly in the hands of men unaccustomed to this type of electrolytic work.

So far as the chemical part of the process is concerned, it does not differ widely from that of the Balbach Thum system, but it has special features in its favour. The plant is worked on similar lines to that used for electrolysis of copper bullion, but its cells and other parts whilst acting in the same manner as that of the Balbach Thum are differently constructed. The layout of the modern plant consists of specially made troughs of earthenware provided with two outlets at the bottom. Within the troughs are several compartments made of porcelain; this differs from the older style in which stout cloth bags were employed as diaphragms. The cast plates of silver to be electrolysed are suspended in those compartments alternately in the trough. Previously the cathodes were made of silver foil, but in recent years these have been substituted by aluminium cathodes. The cathodes are suspended in the spaces between the compartments from copper or brass rods which extend across the trough. The electrolyte flows into the trough and the level is maintained sufficiently high to just cover the electrodes, the spaces in the anode compartments being just sufficiently low to permit its entrance and thus cause slight circulation.

In order to understand how the plant is working, it is necessary to ascertain the ampere efficiency of the deposition of silver, and the weight of anode corroded in one tank per day. According to the figures worked out by Richards, if the silver deposited theoretically by one ampere per day is,

$0.00001035 \times 108 \times 60 \times 60 \times 24 = 96.58$ gms.
220 amperes will deposit $96.58 \times 220 = 21,248$ gms. The ampere efficiency will then be $\frac{19.85}{21,248} = 0.934 = 93.4$ per cent.

This means that 6.6 per cent. of all the silver which the current is capable of depositing is prevented from depositing by the nitric acid present, forming silver nitrate.

Accumulation of Anode Slimes

The electrolyte used is silver nitrate with copper nitrate, and always contains about one per cent. of free acid, which acts chemically upon the deposited silver, or alternatively acts to prevent its deposition. During recent years, however, this acid content has been maintained at about 0.5 per cent.

In order to accumulate all the anode slimes together, the compartments are shaped diagonally at the bottom, so that the outlet from each compartment converges at the same point at the bottom of the trough. Anode slimes which form will then slip down the diagonal compartment to a glass bottle which is fixed at this side at the bottom of the trough. Meanwhile the cathodic deposit of silver is forming on the aluminium sheets, and is scrapped periodically, either by hand or mechanical means. This deposit simply falls to the conical bottom of the trough where a larger glass vessel is fitted. That is, the bottom of the trough has two outlets, a large one at the centre below for the silver deposit and a smaller one at the side below for the anode slimes. From this it will be observed that the troughs have to be specially designed and cast at the potteries for the purpose. The electrolysis is conducted in a battery of these troughs, in one long line several feet above the level of the floor, so that access to the products of the bottles is easy.

Removal of Deposited Silver

For some time the scraping of the cathodes to remove deposited silver was done by a set of scrapers attached to eccentrics. To improve on this the original inventor, Moebius, suggested using an endless silver band as the cathode, from which the silver crystals were brushed off on

emerging from the tank, but more recently it has been found better in actual practice to use hand labour.

In operation the electrolyte circulates the different troughs, flows through their respective compartments and returns to a small filter press. Meanwhile the current causes the deposition of silver and separates the gold and platinum, etc., as anode slimes. The close proximity of the anodes and aluminium cathodes, despite the porcelain diaphragms causes the electrolyte to heat up very markedly. To reduce this, the liquor after filtering is pumped to a small worm condenser overhead by means of a centrifugal pump lined with acid resisting material. From thence, the liquor returns to the troughs and circulates as before. The pump is operated by a mercury switch which in turn is caused to function by means of a cistern arrangement.

As the electrolysis proceeds, the bottles connected to the anode diaphragms are seen to be filling up with a dark slimes deposit, whilst the frequent scraping of the aluminium sheets fills up the cathode bottles with pure silver. When the anodes appear to have almost dissolved away, the current is switched off and the bottles emptied by the same system as is adopted in the electrolysis of copper bullion.

Recovery of Selenium

A By-Product of Electrolytic Copper Refining

THE recovery of selenium as a by-product of electrolytic copper refining was described at a recent meeting of the American Electrochemical Society.

In the treatment of the slime in the Doré furnaces, the major portion of the selenium is volatilised and collected in the dust and sludges from the flues, water scrubbers and Cottrell precipitators. The flue dust and sludges are roasted in a special furnace at a low temperature. This oxidises the metallic selenium to selenious acid which, along with resublimed selenious acid, is collected in the cooler portions of the flue as impure crystals, which are then dissolved in water, filtered and precipitated as selenium in the red amorphous condition by means of sulphur dioxide gas. The remaining selenium and the tellurium in the Doré furnace charge are removed by fluxing with soda ash or caustic soda and sodium nitrate. The soda compounds are leached out of this slag with water, giving a strongly alkaline solution of sodium selenite and tellurite. The tellurium is removed by precipitation as tellurium dioxide on the neutralisation of this solution with crude sulphuric acid. The resulting neutral liquor contains the selenium and, after filtering, is combined with the selenious acid solution previously obtained and the selenium precipitated with sulphur dioxide gas. The drying of the precipitated red amorphous selenium at 100° C. converts it into the black modification. This is then pulverised and screened. When sticks or cakes are required the black powdered selenium is melted under a sodium nitrate flux in cast iron pots from which it is cast as the vitreous modification with its mirror surface and glassy structure.

Present Industrial Uses

The chief use for selenium is in the glass industry, where it is employed both as a decoloriser and in the manufacture of ruby glass. The ceramic industry uses it in conjunction with cadmium sulphide to obtain various red and orange shades of enamel. Of late years it has been used with success in rubber compounding, as it increases the resistance of the rubber to abrasion to a considerable extent. Some is also used for the manufacture of special dyes. With the development of television, selenium cells have been improved considerably, and the lack of uniformity and high inertia of the earlier type of cells have been corrected. Several makes of cells are on the market to-day which are guaranteed to give satisfactory service. For the glass, ceramic, rubber and dye industries, selenium pulverised to pass 100 mesh and analysing not less than 99 per cent. of selenium, is usually specified. For cell purposes the vitreous selenium, cast in either stick or cake form, is used.

Some Recent Metallurgical Patents

Ferro-Phosphorus Alloys

FERRO-phosphorus low in or free from silicon, and containing, for example, over 22 per cent. of phosphorus, is made by heating to not more than 1,650° C. a neutral or basic charge not containing a substantial proportion of alumina and containing an amount of free or combined silica which does not exceed the equivalent of the whole of the bases present. The charge contains a reducing agent such as carbon, and sufficient iron to combine with the phosphorus set free from the phosphates. The process may be carried out in a coke-fired blast furnace. (See Specification No. 372,412, Metallges, A.G., and Hochfengwerk Lübeck, A.G.)

Hard Alloys for Tools

A SINTERED hard alloy for implements and tools may be prepared from a mixture of vanadium carbide with niobium carbide or tantalum carbide or both as one component and a metal of substantially lower melting-point such as iron, cobalt or nickel as the other component. In an example the alloy is sintered at about 2,000° C. and consists of approximately equal parts of vanadium carbide and niobium carbide with an addition of 2.5-5 per cent. of iron or cobalt. The metal component such as iron may amount to about 25 per cent. of the whole alloy, and the sintering may take place simultaneously with or subsequently to the pressing of the initial powder mixture. (See Specification No. 360,854 of Tool Metal Manufacturing Co., Ltd.)

Nitrogenising Steel Alloys

STEEL alloys containing 9-17 per cent. of manganese, 2.5-10 per cent. of nickel, and up to 1 per cent. of carbon, and if desired from 0.1 to 10 per cent. of one or more additional elements such as silicon, chromium, tungsten, aluminium, copper, molybdenum, cobalt, vanadium titanium or zirconium can be nitrogenised by heating at a temperature from 500° or 550° C. and upwards to 650°-680° C. in the presence of ammonia or a substance from which ammonia is evolved when heated. The heating may be carried at one or different temperatures. Before the nitrogenisation, the alloys are toughened by heating to 900°-1,000° C. and quenched. (See Specification No. 360,918 of R. A. Hadfield and W. J. Dawson.)

Refining Iron and Steel

IN the process of melting and refining steel, a non-oxidising gas may be passed in a closed circuit upwards through a shaft furnace and downwards through a gas-heating stove containing incandescent solid fuel. The furnace may be associated with two stoves, which are blown hot, and used for heating the circulating gas alternately, and where a single stove is used the gases produced during the hot blowing stage are passed to the furnace, in which they are burnt with pure or nearly pure oxygen. The metal melted in the shaft may be refined in a coal-dust fired open-hearth furnace, the products of combustion from which are passed to the shaft. When the process is used for the production of steel from scrap the refining may be effected by oxygen, or by a coal-dust oxygen flame. (See Specification No. 360,931 of Soc. Oxythermique.)

Recovery of Molybdenum and Tungsten

MOLYBDENUM and tungsten carbonyls may be prepared by the action of carbon monoxide under pressure at a temperature of at least 210° C., preferably at least 225° C., on molybdenum and tungsten or materials containing these metals in the metallic state, preferably those which have been obtained by a reducing treatment in the presence of copper or its compounds. The metal carbonyls can be separated from the excess carbon monoxide by cooling or washing, for example, with benzene or ether, and the carbonyls of molybdenum and tungsten separated from those of other metals which may be present by sublimation or crystallisation. The process is suitable for recovering molybdenum and tungsten from their ores or other materials which are reduced to give the free metals before treating with carbon monoxide. By thermal decomposition of the carbonyls, molybdenum or tungsten are obtained in compact, powder or sponge form. (See Specification No. 370,804 of J. V. Johnson, a communication from I. G. Farbenindustrie.)

Thermo-Aluminic Processes

THERMO-aluminically produced iron for use in welding is improved by the addition of one or more of the metals nickel, cobalt, molybdenum and vanadium, with or without the further addition of tungsten. Additions of nickel and cobalt are preferably made along with chromium, and additions of molybdenum, tungsten and vanadium along with titanium. The additions may be used in the form of free metals or as alloys, preferably ferro-alloys, or as oxides along with the necessary amount of aluminium powder, and they may be added to the reaction mixture prior to or at the end of the reaction, or may be placed in the mould surrounding the material to be welded and thermo-aluminically produced iron thereupon run in. (See Specification No. 369,843 of Goldschmidt, A.-G.)

Pickling and Cleaning Metals

IN pickling or cleaning metals with dilute non-oxidising acids a small proportion of a "natural or synthetic ichthyl or ichthyl sulphonate" may be added to the acid to prevent attack of the metal. Natural ichthyl products are prepared by the sulphonation with concentrated sulphuric acid or oleum of the sulphur-containing oils obtained by the low temperature carbonisation of certain oil shales. The acids or their soluble salts may be used. Synthetic ichthyls or ichthylsulphonates are prepared by sulphonation of the product obtained by treating mineral oils with sulphur at about 200° C. or by the sulphurisation of sulphonated mineral oils. Dry or pasty products for addition to the pickling or cleaning acid may be obtained by mixing the ichthyl product with salt of a foam-producing agent. (See Specification No. 370,871 of Imperial Chemical Industries, Ltd.)

Refining Lead

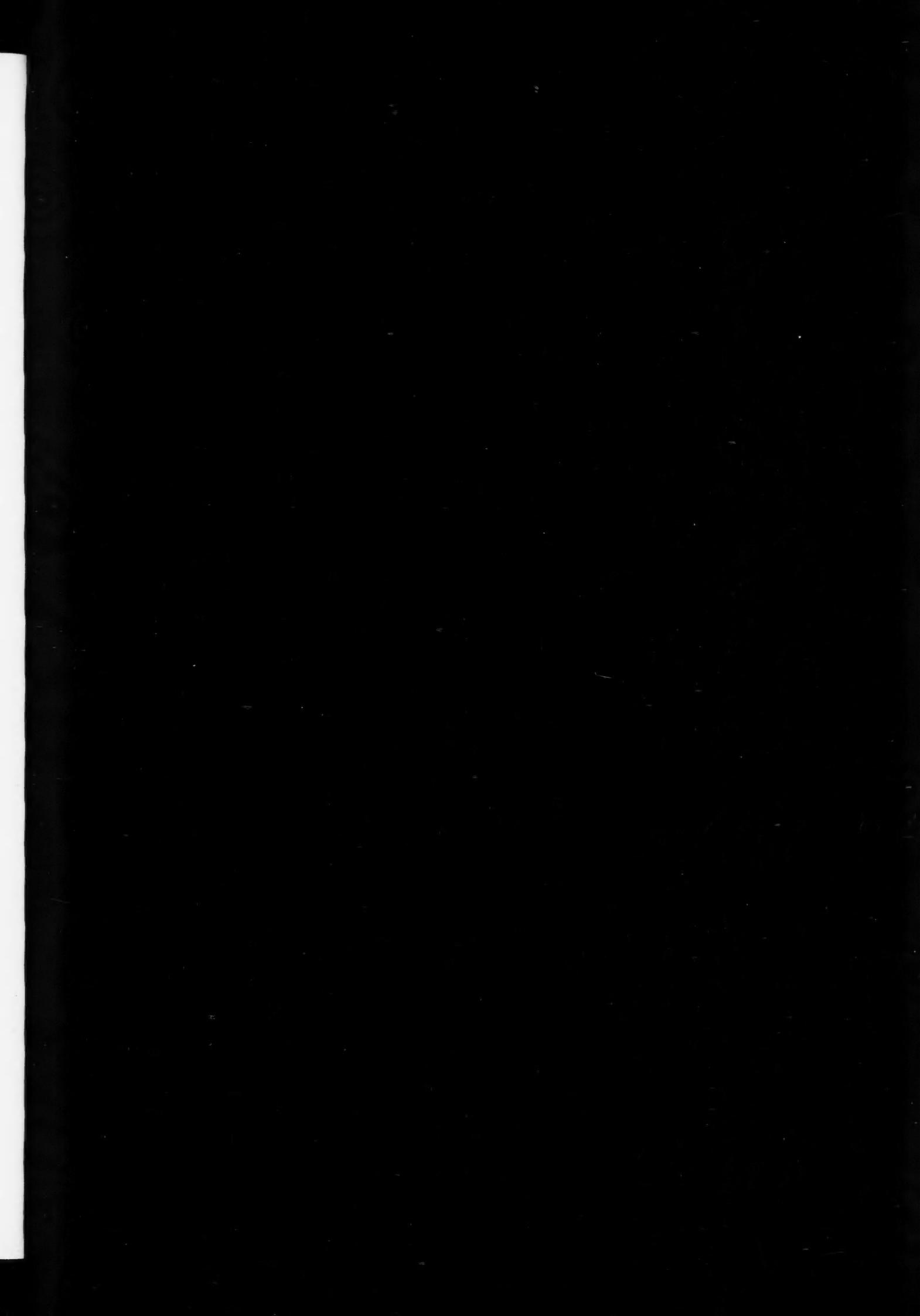
A PROCESS for removing silver and bismuth from molten lead, in which the silver is removed by zinc and the bismuth by an alkaline earth metal, is described in Specification No. 370,027, of the American Smelting and Refining Co. In carrying out the process sufficient zinc is added to form a silver dross, which, after pressing is removed. The bath is cooled, zinc plates are added and the further dross formed is cast in blocks suitable for desilverising subsequent lead baths. After further cooling to about 650° F., calcium, preferably as a lead calcium alloy, is added to the bath to form a bismuth-calcium-lead-zinc dross, which is removed. By still further cooling the bath more blocks of zinc-silver dross are formed. On now adding chlorine to the bath the first slags formed contain all the excess calcium with a little zinc and may be used for treating the bismuth dross. The final slags are free from calcium. The bismuth dross may be treated by melting under a zinc chloride calcium chloride slag at about 1,000° F. whereby the calcium enters the slag reducing an equivalent quantity of zinc. The calcium-free bath may be treated by liquation for the removal of zinc, the solid crusts being retorted to recover zinc.

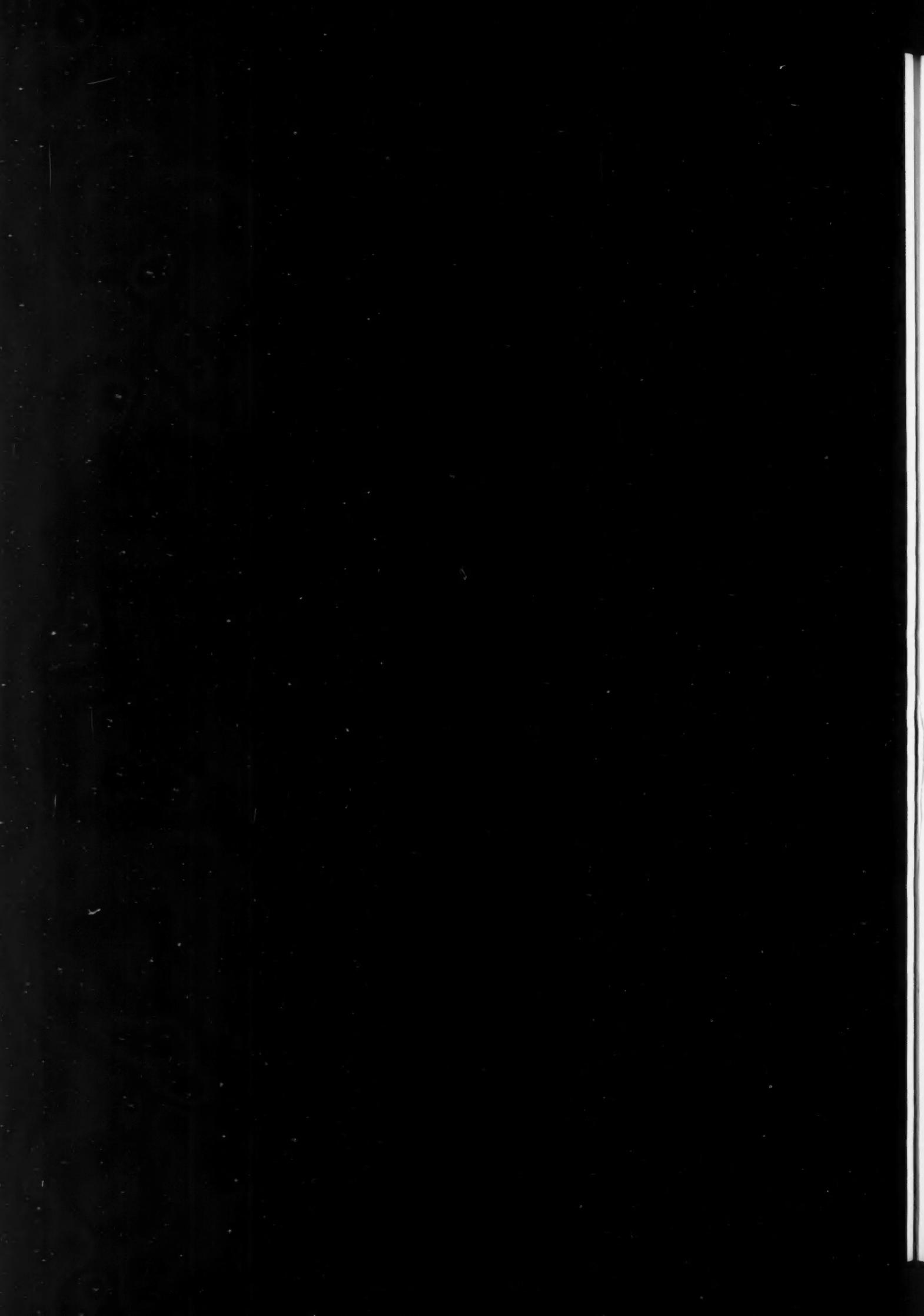
Platinum Production in Canada

THE Dominion Bureau of Statistics at Ottawa has issued its finally revised statistics on the output in 1931 of metals of the platinum group indicating that 91,693 fine ounces of platinum, palladium, rhodium, iridium and ruthenium valued at £563,000 were produced from Canadian ores in 1931, as compared with 68,116 fine ounces worth £488,000 in 1930. During the year 14,202 ounces of platinum valued at £227,000 (contained in concentrates or in other forms) together with 8,1 ounces of scrap were exported. Of these concentrates 13,528 ounces went to Great Britain and 672 ounces to Norway.

Embrittlement of Steels

IN the recent annual memorandum to the Manchester Steam Users' Association, the chief engineer discusses factors influencing susceptibility to embrittlement of steels in the steam range. Attention is drawn to the toughening effect of molybdenum additions to nickel alloy steels, and to the importance of correct heat-treatment of the steels prior to use in the embrittling range.





Metallurgical Section

November 5, 1932

Re-organisation for the Iron and Steel Industry

THE first report of the National Committee set up by the iron and steel industry to work out schemes of re-organisation and development was published on October 22, embodied in a report of the Import Duties Advisory Committee recommending that the duties on iron and steel products be continued for two years. Simultaneously, a Treasury Order was also issued, under which the existing duties on iron and steel (33½ per cent. *ad valorem*) are now extended until October 25, 1934. The National Committee, it will be recalled, was appointed at a meeting of leading representatives of the industry convened by the Advisory Committee at the commencement of June. Its purpose was to work out schemes of re-organisation and development, which "with the assistance of an adequate scale of tariff protection" might help in restoring efficiency and prosperity in the iron and steel industry.

The first report of the National Committee, as now published, gives a general survey of the existing situation and of the chief difficulties standing in the way of effective re-organisation. In the first place attention is drawn to the severity of the general industrial depression on the iron and steel industries of the whole world, and to the intensified international competition which has resulted. Prices, it is pointed out, are at a very low level, and, according to authoritative statements by representatives of the organisations of iron and steel manufacturers on the Continent, export sales during this year have been at prices far below the actual cost of production. Before the adoption of protective measures by this country the British industry was suffering from this uneconomic competition to an exceptional degree owing to its relatively higher standards of wages and labour conditions. In consequence there is little cause to be surprised at the cumulative effect of the adverse competitive conditions, not only in the immediate reduction of trade and in increased costs consequent on smaller output, but also in the depletion of the industry's reserves and the resulting postponement of plant renewals and improvements. In this way a "vicious cycle" has been set up, and a policy of adequate protection was necessary to effect a reversal of this cycle, aided by vigorous and prolonged effort on the part of all concerned in restoring the industry to its former position.

The task which the National Committee has undertaken is not a light one. Its first objective is to ensure that all the iron and steel requirements of this country, both in semi-finished and finished form, are met to the maximum possible extent by the British iron and steel industry. Secondly, it has to effect such re-organisations and adjustments in the industry as are necessary to enable requirements being met at the lowest possible

cost and with the maximum resultant expansion in the trade of the country. Thirdly, an attempt is to be made to stop wasteful competition between manufacturers. Definite progress, we are assured, has already been made towards the attainment of these objectives. Arrangements as to price and supply will naturally present less difficulty than the processes of re-organisation, but goodwill and desire for co-operation in the latter direction is manifest on all sides in the negotiations which have so far taken place.

While emphasising the need for the industry to be put on a profitable basis if it is to attract the capital necessary for re-organisation and re-equipment, the National Committee state that they regard expansion of output (with consequent reduction of costs of operation) as even more important than an improvement in the level of prices. They point to the dependence of the industry on the export trade in all forms of iron and steel products—some 70 per cent. of its output in normal times—as a sufficient guarantee that a policy of price agreement could not be pressed to the detriment of consumers and finishers of the primary products. It is therefore intended to press forward with re-organisation in every possible direction calculated to increase efficiency and reduce costs of production, thus cheapening the price to consumers, and here it is that the committee urged some greater measure of assurance in regard to tariff protection as being an essential condition of progress. Uncertainty as to the duration of the existing duties is stressed as being a further handicap to progress, since it encourages foreign producers to continue their price cutting in order to retain their hold on the market in the hopes that the duties in question may be reduced. With this point in mind the committee were of the opinion that the existing duties on iron and steel should be imposed for a period of at least two years. With the issue of the new Treasury Order we have therefore to await further details of progress, being reminded that the continuance of these duties until October, 1934, is "subject to satisfactory progress being made in the preparation of a scheme of re-organisation, and in putting the approved scheme into force."

We are told that the industry has now devised an organisation which is progressively working towards a national solution of its many problems. In some cases it is necessary to proceed on the basis of a separate industry, such as sheets, tinplates, wrought iron, special steels, castings and forgings. Progress is being made in connection with the problems involved in these sections of the industry, particularly in the direction of regulating supply to demand and concentrating production in the most efficient centres, at the

same time eliminating uneconomic competition which has resulted in the past in the dissipation of capital without any increase in the volume of consumption. It is contemplated that the existing organisations will, with growing experience, become consolidated and established on a permanent basis so as to ensure that the industry is governed in the future by a policy directed to increase its competitive power in the export markets of the world, and to co-operate with its consuming industries in the home market as well as the foreign markets.

Obsolete Blast Furnace Plant

IN his recent presidential address to the Institute of Fuel, Sir Hugo Hirst pointed out that pig iron can be delivered into this country more cheaply than we can produce it. Among the several reasons given for this deplorable state of affairs, the most outstanding one is that a large proportion of our iron and steel plant is out-of-date. Except for a few modern blast furnaces, the two largest of which can produce about 3,000 tons of pig iron per week, the industry generally is endeavouring to carry on with obsolete plant, as there are not more than six or seven really modern blast furnaces in the whole of the North of England. The true state of affairs becomes more noticeable when it is stated that 162 furnaces were required to produce the British monthly output of 631,000 tons for 1930, whereas 157 furnaces in the United States produced 3,500,000 tons. The erection of modern blast furnace plant of larger capacity therefore seems to be an essential prelude to the permanent recovery of the iron trade in this country. In 1930 one of the furnaces working at full capacity had an average weekly output of only 300 tons. The furnace which has been erected at the new works of the Ford Motor Co., Dagenham, Essex, will have a weekly output of 3,500 tons, and, apart from being the only furnace in the South of England, it will be the largest and most modern one in the British Isles. The top of this furnace is provided with a special system of double bells, all electrically operated and interlocked. The furnace itself is entirely water-cooled and is provided with a Brosius electric gun for the tapping hole, whilst the engine hoist is electrically operated. About 2,000 tons of ore, limestone and coal will be used every 24 hours to maintain the full output capacity. A Dorr thickener has been added to the installation for the purpose of reclaiming the fire iron dust produced in the furnace, and this unit has been designed for dealing with 40 tons of solids per day. In carrying out this duty it will use about 2 $\frac{1}{4}$ million gallons of water per day, the water in question being drawn from the River Thames which is adjacent to these works.

Magnesium Manufacture in Japan

CONSIDERABLE progress is being made in the Far East with regard to the production of metallic aluminium and metallic magnesium. In Japan deposits of the usual aluminium ores do not exist in any appreciable quantity, but an attempt is being made to utilise clay and alunite which is abundant in Korea. It is reported that actual manufacturing operations are shortly to be commenced by the Japan Nitrogen Fertiliser Co. and the Showa Fertiliser Co., but details of the process which will be employed have not been revealed. This development, however, is of immense

importance to Japan, where imports of manufactured aluminium metal amount to about 11,000 tons per year, supplies coming chiefly from the United States. Raw magnesite for the production of magnesium is obtained in Manchuria, and great hopes are entertained with regard to a wider utilisation of this metal in the form of light metal alloys. A magnesium plant is already working at Kashiwazaki, where the process adopted is based on the electrolysis of a fused mixture of magnesium chloride and potassium chloride. Here a novel method for preparing the magnesium chloride is in operation. Very dilute chlorine gas from the electrolytic cells is passed through milk of magnesia, which is obtained by lixiviating calcined magnesite with water. In the presence of a suitable amount of cobalt salt the formation of hypochloride and chlorate is prevented, and calcium, manganese, iron and silica which accompany the raw magnesite are thereby precipitated whilst comparatively pure magnesium chloride remains in solution and can be recovered as the crystalline salt. This crystalline salt is subsequently fused to give the anhydrous salt, ready for charging into the electrolytic cells. Another scheme, studied in the Tokyo Imperial Industrial Laboratory, aims to prepare anhydrous magnesium chloride in a dry way by passing chlorine and carbon monoxide on the heated mixture of carbon and calcined magnesite. A third attempt is being made to recover magnesium and potassium from waste brine or bittern obtained in those districts where solar evaporation is practised on a large scale for the production of common salt.

Metallic Moulding Powders

THE editorial note on metallic moulding powders, which appeared in THE CHEMICAL AGE, October 1, 1932, Metallurgical Section, page 20, has excited considerable interest in manufacturing circles, judging by the number of inquiries which have been received asking for further information upon these products. A lengthy article upon powders of this type appeared in the issue of "Stahl und Eisen" for September 1 (pp. 845-849), where the process of sintering is described as applied to carbonyl iron and its application to the manufacture of iron alloys is indicated. In this article special attention is directed to the potentialities of the process in relation to magnetic nickel-iron alloys, such alloys of controlled coefficient of expansion, and bimetal alloys. The production of moulding powders is described in French Patents No. 671,626 (1929) and 701,064 (1930), granted to the I.G. Farbenindustrie. It is understood that similar powders are also being manufactured in the United States, possibly by thermal decomposition of the corresponding metallic carbonyl. An alternative method of producing such powders consists in electrolysing a solution of one of the metallic salts, employing conditions which tend to produce spongy metal at the cathode. The deposited sponge is then washed, dried, pulverised and sifted, different gradings being employed for the production of metal of different densities. The production of semi-solid metal from metallic powders by a sintering process was first used on a commercial scale in the manufacture of tungsten, the tungsten powder, in his case, being obtained by the reduction of tungsten oxide in a stream of hydrogen at elevated temperature.

Nickel-Clad Steel Plate and Sheet

A Useful Material for Chemical Plant Construction

THE properties of nickel as a corrosion-resisting material have long been recognised and made use of for a wide variety of purposes. Prior to its production in a malleable form, nickel was employed in the form of an electrolytic deposit to provide surface protection from atmospheric attack for the more readily corrodible materials, such as steel and brass. Its use in this way, and also as a protective undercoat to chromium, has steadily grown and is to-day more extensive than ever before. While the use of this type of surface protection satisfies many requirements, its applications in the corrosion-resisting field, for a variety of reasons, are definitely limited.

When nickel became available in malleable form, there was placed at the service of industry a material having a strength equivalent to that of steel, and with very marked corrosion-resisting properties. The resistance of nickel to the attack of alkalies in general is of a high order, while wide use is being made of the metal where inorganic and organic acids have to be handled. Nickel equipment is also being employed in the preparation of numerous neutral substances and in the foodstuffs industries. For the majority of applications,

clad steel plates is the production of a true bond between the surfaces in contact. Fortunately nickel and iron are mutually soluble in all proportions, and if the surfaces in contact are kept clean during the heating process, it is possible to obtain a good bond simply by hot rolling. This having been obtained, the working properties of nickel and steel are sufficiently alike to permit the rolling of the composite slab to whatever thickness is desired. Since the plates are made throughout by hot rolling, the normal finish is that of hot-rolled steel and hot-rolled nickel. The nickel is covered by a thin, tightly adherent and glossy oxide film, dark olive brown in colour, which has very good corrosion-resisting properties. If necessary, this thin film may be removed by subsequent treatment of the nickel surface. The thickness of nickel may be varied at will to suit the particular service conditions. Perhaps the most widely used nickel-clad plate is $\frac{1}{8}$ in. thick, having a nickel covering of 10 per cent.

The accompanying photomicrograph (Fig. 2) shows an etched section through a nickel-clad steel plate, and illustrates the bond which is obtained by the process described. The top

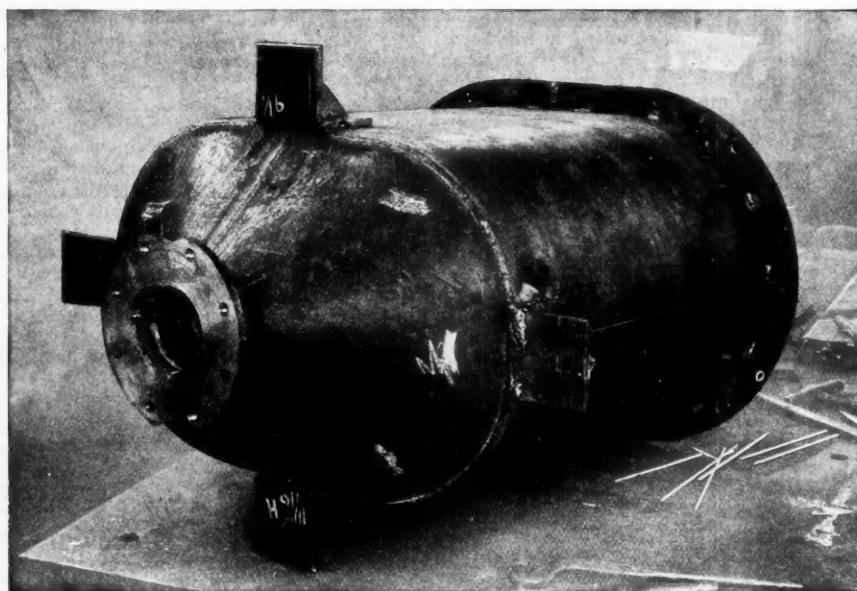


Fig. 1.—Tapered-bottom Nickel-Clad Steel Vessel for use in the Manufacture of Plastics.

relatively light-section metal has been required, the use of nickel for heavy plant parts being somewhat limited owing to the high initial cost of using the solid metal. In such cases the designer has had to choose between employing a thicker section of a more readily corrodible material, or adopting a steel or cast iron structure with a lining of nickel. The first alternative is, of course, very undesirable, since it is bound to cast doubts as to the safety of the equipment and the purity of the product. The use of a sheet nickel lining, on the other hand, although adopted successfully in many instances, is not entirely satisfactory for a wide range of applications, particularly where questions of heat transfer are of importance.

In recent years, however, there has been developed a composite product consisting of nickel rolled on steel. This material, in the form of nickel-coated steel sheet and strip, has been on the market for some time, but the production of nickel-clad steel plate has only been perfected within the last three years. Such plates are protected on one side by a covering of malleable nickel. This covering, which has all the corrosion-resisting and other properties of ordinary commercial hot-rolled sheet nickel, is firmly bonded to the steel, and the mechanical properties of the composite plate are such that it can be treated by the designer as a solid steel plate.

The most important factor in the manufacture of nickel-

and bottom portions of the illustration exhibit the typical structures of the nickel covering and the steel base plate respectively. The narrow band between these is the bond or alloy area (consisting of a solid solution of nickel and iron), which is formed when the two metals are brought into intimate contact under pressure at elevated temperatures. This method of bonding differs from autogenous welding in that the bond is produced at temperatures below the melting point of either metal, being obtained by the interdiffusion of iron and nickel. This continuity of metal throughout the section of the composite plate is of value in many applications where heat transfer is of importance, no air film being present as occurs when a separate lining of sheet metal is adopted.

Fabrication of Equipment

In the fabrication of nickel-clad steel equipment, cold operations, such as bending, flanging, forming, etc., can all be carried out exactly as in the case of steel. For cold pressings it is generally necessary to use annealed plates. Hot working also follows the same procedure as for steel so far as temperature, tools and methods of working are concerned. It is essential, however, to prevent possible injury to the nickel by exposure to sulphurous furnace gases, both when annealing for cold pressing and when heating for hot working. As

the applications of nickel-clad steel plates are all concerned with problems of corrosion resistance, special interest centres on joints. It is necessary in the majority of plant parts made in this material, to have an unbroken nickel surface, and continuity is obtained by welding with nickel. If this were not

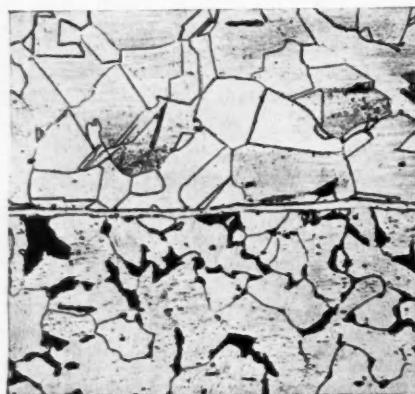


Fig. 2.—Typical Nickel to Steel Bond ($\times 200$)

done, galvanic action would be set up, resulting in enhanced corrosion of the steel base plate at the joint. Welding may be carried out either by the electric arc method or by the oxy-acetylene flame, but for heavy steel plate the former method is more generally employed. Two typical welds in nickel-clad steel plate are shown in Fig. 5. In some cases it may be necessary to use a combination of riveting and welding, nickel rivets being used.

Typical Applications

Although the production of nickel-clad steel plates on a large scale has been undertaken only within the last three

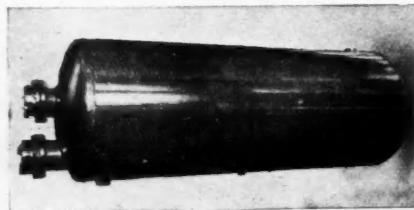


Fig. 3.—Nickel-Clad Steel Hot Water Tank

years, this material is already being fairly extensively employed. The first commercial equipment manufactured was an 8,000 gallon railroad tank car. This car (Fig. 4) was put into service in October, 1930, and is employed for transporting iron-free and copper-free liquid caustic soda, as used, for example, in the manufacture of artificial silk. Nickel, being immune from attack by caustic soda, is an ideal metal for use in contact with this reagent. Following on the success of this initial equipment, the use of nickel-clad steel plate has expanded rapidly, particularly in the manufacture of caustic soda—for forced circulation vacuum evaporator bodies; in dyestuff industries—for hoppers, dye kettles, and tanks for large reel tank dyeing machines; in cellulose acetate manufacture—for mixer bodies of steam-jacketed mixers; in plastics manufacture—for tanks; in the textile industries—for agers, sizing drums and peroxide bleaching kiers; in soap manufacture—for soap storage tanks, boiling kettles, and cooling machines; in the laundry equipment—for hot water heater tanks; in varnish manufacture—for the bottoms of varnish kettles; and in the foodstuffs industries—for equipment handling fruit and vegetable juices, butter, oleo margarine, syrups, etc.

The properties of nickel-clad steel plate make it admirably suited also for such parts as outside shells of centrifugal extractors, hydraulic press plates, filter tanks, chutes, conveyor pans, elevator buckets, settling tanks, rotary drier shells, condenser shells, storage bins, etc. In short, it is

suitable for all heavy equipment where the properties of nickel are desirable, but where solid nickel would be too costly, and where the use of a separate lining is not practicable.

Nickel-Coated Steel Sheet

The thinner materials, known as nickel-coated steel sheet and strip, consist of sheet or strip steel covered by a thin layer of malleable nickel, both metals being firmly bonded together over their entire surface of contact. In their production a composite slab is used, consisting of a nickel plate and a steel plate suitably held together. This composite slab is heated to the required temperature and then hot rolled to obtain the necessary bond. The final rolling operations are done by cold rolling, and the finishes obtained are those of cold-rolled nickel and cold-rolled steel, namely, bright and



Fig. 4.—Tank Car made in Nickel-Clad Steel for transportation of caustic soda liquid.

smooth. The nickel coating may be either on one side of the steel or on both sides, while the thickness of the nickel may be arranged to suit service conditions.

As nickel-coated steel sheet and strip have been available for a number of years, they now have many well-established uses. The malleable nickel coating is non-toxic, corrosion-resisting, hard-wearing and capable of taking a very high polish. The fact that subsequent plating operations are not necessary after forming articles to shape is an advantage which will readily be recognised. Further, the protection against corrosion afforded to the underlying steel by the nickel coat is superior to that given by electrolytic deposits.

It must be remembered that the useful service obtainable

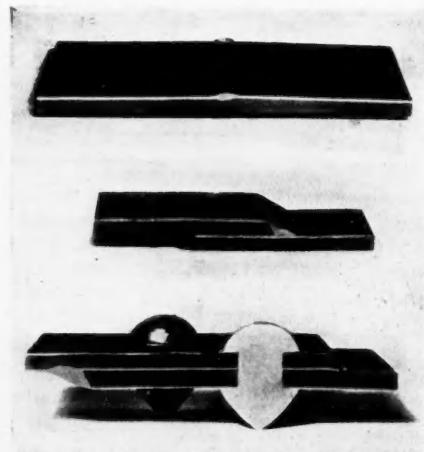


Fig. 5.—Typical Joints in Nickel-Clad Steel.
Top: Butt-Welded Joint. Center: Lap-Welded Joint.
Bottom: Lap Joint Double Riveted.

from nickel-clad steel plate and nickel-coated steel sheet and strip is entirely dependent on the life of the nickel covering, and therefore on the thickness of the nickel. Once this covering has been perforated at any point, corrosion of the underlying steel will proceed at that point if the steel were unprotected. For this reason the employment of the above materials should not be resorted to when the conditions are such that the use of a solid corrosion-resisting metal or alloy would be justified.

Copper Restriction Plans

Remote Possibilities of New Agreement

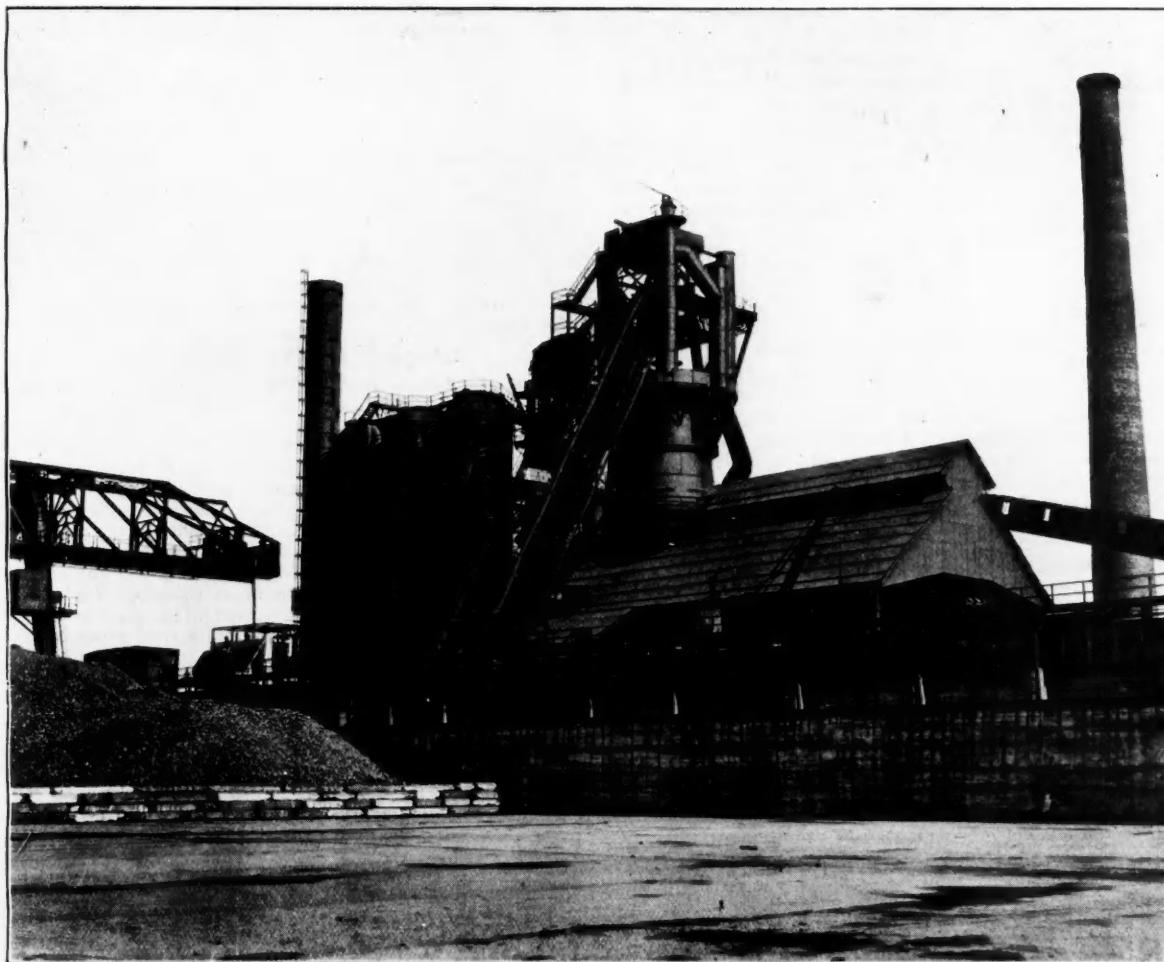
COPPER producers will soon have to decide whether or not restriction of output is to be continued. Under the present agreement which came into operation in April last, the output of the leading producers is curtailed to 20 per cent. of capacity, but this arrangement comes to a close at the end of the year. It is reported from the Metal Exchange that an attempt is to be made to control production for a further period. For that purpose a conference of the world's producers is likely to be called some time next month, when the opportunity will also be taken to discuss various other matters affecting the industry.

The existing agreement having failed to bring about the improvement expected, it is doubtful, however, if a majority of the producers can be induced to continue the experiment. Since April the influence of the Copper Exporters, Inc., in the international copper market has been greatly reduced by the secession of a number of the large producers, while the various tariff Acts which have been passed recently make it more difficult to enforce a general scheme of restriction. The decision of the British Government to impose a duty of 2d. per lb. on foreign copper promises to provide a further

serious obstacle. Apart from tariff considerations a number of the leading producers has recently shown a desire to put an end to all restrictions on output, this being specially marked in the case of the low cost undertakings. The Union Minère du Haut-Katanga, of Belgium, is reported to have already demanded special treatment if its support is to be secured for a continuance of the agreement, which may arouse the antagonism of other producers. The Rhodesian companies, which are exceptionally well placed so far as working costs are concerned, are also reported to be in favour of the restoration of complete freedom in the industry. Certain individual companies hold the same views.

It is understood that American copper interests in New York are arranging an international meeting of producers to discuss the question of establishing a new plan for restriction of output. Delay in holding this meeting is possibly due to a desire to discover whether Great Britain is inclined to follow up the Ottawa treaties with a tariff on copper favouring South Africa, and also to get some inkling regarding the probable policy of Mr. Roosevelt (if he is elected president) regarding tariff duties on raw materials.

A Feature of the New Ford Works



A view of the Blast Furnace, at the New Works of the Ford Motor Company, Dagenham, as seen from the ore yard.

Some Recent Metallurgical Patents

Heat Treatment for Copper Alloys

IN treating copper alloys containing one or more of the elements cadmium, nickel and silicon, the alloys are hot rolled, quenched, reduced in cross section by mechanical means, and tempered at 250 to 600° C., the reduction and tempering being carried out at least twice. In an example an alloy containing 2.0 per cent. of nickel, 0.4 of silicon and 0.6 of cadmium is drawn, after hot rolling and quenching, to a diameter of about 3 mm. at ordinary temperatures, is heated to 450° C. for 1½ hours, drawn again to a diameter of 1.6 mm. and heated to 350° C. for 2 hours. (See Specification 378,388, of Furukawa Denki Kogyo Kabushiki Kaisha.)

Preventing Formation of Zinc White Rust

ZINC or zinc coated metal articles can be treated to prevent the formation of white zinc rust by immersing them in a solution of chromic acid, washing, and drying. A treatment by immersion for 5 seconds in a 0.5 per cent. solution of chromic acid is described. If the articles are stained with a film of oxide, hydroxide, or carbonate this film may first be removed by pickling, or the treatment in the chromic acid solution may be prolonged until a visible film of zinc chromate is formed. The chromic acid bath may be placed between a galvanising bath and a washing bath, or the article may be galvanised, washed, treated in the chromic acid bath, and again washed. (See Specification No. 377,746, of K. D. Mackenzie and A. C. Barclay.)

Refining Scrap Lead

LEAD alloys containing metals such as tin, antimony, and copper, particularly scrap storage battery plates, can be refined by heating the material in a furnace, drawing off the comparatively pure melted lead, further heating the remaining material with the addition of reducing agent, and drawing off the resulting lead-antimony alloy which is comparatively high in antimony. Litharge may be added to the initial material, and molten lead and litharge may be drawn off together to further refine the lead; or the scrap may be melted with reducing agent. The scrap may be so melted as to produce a pool of lead covered with oxide, and the pool may be agitated with the oxide to transfer antimony from the lead to the oxide. (See Specification No. 377,298, of P. W. Davis.)

Nitrogenising Alloy Steels

IN hardening alloy steels by nitrogenising, the oxide film on the surface of the steel can be removed by treatment with a reducing agent (e.g., nascent hydrogen) and the steels are then nitrogenised in the usual manner. The oxide film may be removed by treatment with a hydrogen-liberating acid such as hydrochloric acid; by treatment in an electrolytic bath or by heating in a current of hydrogen or in contact with other known reducing agents. The following alloy steels are referred to: 18 per cent. of chromium and 8 of nickel; 14 per cent. of chromium 0.2 of nickel and 0.3 of carbon; 22 per cent. of chromium, 12 of nickel, 3 of tungsten and 0.3 of carbon; 4 per cent. of chromium, 12 of nickel, 5 of manganese and 0.5 of carbon. (See Specification No. 377,244, of W. H. Hatfield and H. Green.)

Removal of Phosphorus from Steel

IRON and steel containing more than the usual amounts of phosphorus can be improved by the addition of copper during the production of the steel. The copper in the finished steel may amount to 0.15 per cent. or more. Deoxidising agents such as silicon, aluminium, titanium, etc., may be used. (See Specification No. 377,153, of Vereinigte Stahlwerke A.G.)

IN the production of steel or iron containing copper and phosphorus the phosphorus content can be obtained wholly or partly by means of reducing agents such as aluminium, silico-aluminium, ferrosilicon, etc., which reduce the phosphorus from the slag and simultaneously deoxidise the slag and return manganese into the metal. Thus in the Bessemer convertor if the process is interrupted when the phosphorus content is 0.135 per cent. it may be raised to 0.226 per cent. by the addition of ferromanganese and silico-aluminium. (See Specification No. 377,167, of Vereinigte Stahlwerke A.G.)

Removal of Oxides from Aluminium

OXIDES and gases can be removed from aluminium and aluminium alloys by means of a mixture of carbon tetrachloride and an alkali bifluoride, particularly ammonium bifluoride, with or without the addition of silicon chloride. Carbon tetrachloride may be wholly or partly replaced by antimony pentachloride or manganous chloride or both. If the aluminium alloys to be treated contain zinc, zinc chloride with or without silicon chloride may be used along with the above reagents. Liquid chlorides used as reagents may be absorbed in charcoal powder before use. (See Specification No. 377,079, of K. Schmidt Ges.)

Treatment of Metallic Ores

IN removing copper, cobalt, and nickel from iron ores, the finely divided oxidised or roasted ore containing ferrous oxide or ferroso-ferric oxide can be treated in a "quasi-wet" condition and under agitation with chlorine or sulphur dioxide, the quasi-wet condition being maintained at least until the ferrous oxide has reacted with the gas employed. Thereafter the temperature is raised to decompose the ferrous salt formed and in the presence of air to form chlorides or sulphates of the metals to be removed, which are recovered by leaching. The ore may be subjected to preliminary reduction treatment to provide ferrous oxide therein. (See Specification No. 377,705, of Meyer Mineral Separation Co.)

Separation of Metal from Gangue

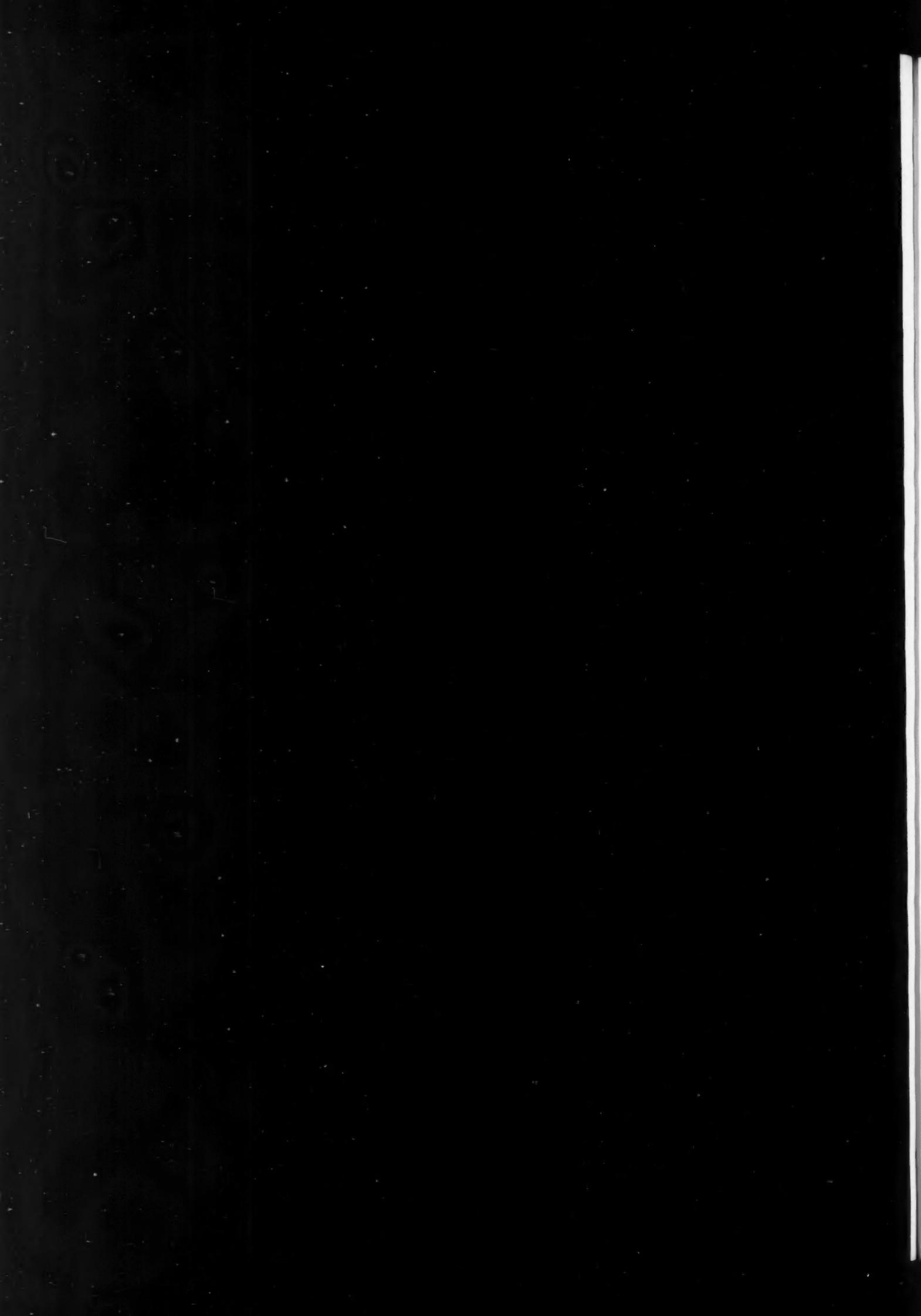
METALLIC particles can be separated from gangue by flowing a suspension of the metal and gangue in a hydrocarbon oil over a concentrating table. Preferably the table has longitudinal riffles between which the metallic particles settle and are carried to a discharge trough at one end of the table, the gangue in suspension being deflected by cross currents to a discharge trough at one side of the table. The oil is then separated from both the concentrates and the gangue by sedimentation or distillation and is re-used to concentrate a further quantity of the mixed metal and gangue. Any metal particles which have been retained in suspension with the gangue are recovered by subjecting the gangue, preferably after removal of the oil, to a magnetic separation. The material to be treated is preferably classified by size before concentration. (See Specification No. 377,260, of Trent Process Corporation.)

Nickel-Chromium-Iron Alloys

ALLOYS containing iron, chromium and nickel can be made by reacting on nickel matter with ferrochromium containing carbon. The alloy may be further refined to remove excess carbon by oxidation, for example, by means of a slag or by Bessemerising with oxygen or air enriched with oxygen, etc. For making alloys of the stainless type the iron nickel chromium alloy may be diluted with iron before or after refining. Additions of other elements may be made to the steels for improving the properties. In examples the mixture of matte and ferrochrome with lime and fluorspar is charged on to a molten bath of lime and silica in an open arc furnace, to produce the ferrochrome nickel alloy. The alloy is treated directly in a convertor or is diluted with steel scrap, tapped into a convertor and blown, ferromanganese and ferrosilicon being added to the ladles before casting the ingots. (See Specification No. 377,519, of Electro Metallurgical Co.)

Corrosion Test on Nickle-Plated Steel

THE Joint Committee of the American Electroplaters' Society, the American Society for Testing Materials and the Bureau of Standards has published an outline of the procedure adopted in the preparation of the standard samples to be used in atmospheric exposure tests on electroplated steel. Information given relates to cleaning procedure and to solutions and plating conditions used in standard, high-temperature, and low *pH* nickel-plating on steel and in deposition of nickel over zinc or cadmium coatings. Particulars of conditions for chromium-, copper-, zinc- and cadmium-plating are also given, and tables show the thickness of plating deposited on the various samples. The exposure tests were begun in the Spring of 1932.



Metallurgical Section

December 3, 1932

Continued Progress in Alloy Steels

DURING the past two years the use of alloy steels has shown a notable advance, in spite of a curtailment of production due to the falling-off in demand by the ultimate consumers of steel products. The vast and constantly growing knowledge of the effect of alloying elements on the properties of iron and steel has made it possible to manufacture steels which really fulfil the requirements of the user. Competition and also the necessity for rigid economy have created a demand for steels possessing great strength and ductility, resistance to shock, impact and fatigue, or resistance to abrasion, corrosion and oxidation, the latter characteristics being sought especially at elevated temperatures. Improved physical properties of present-day steels and irons, resulting from the proper use of ferro-alloys in their manufacture has been another notable advance.

Probably the most important recent development of alloy steels is in the corrosion-resisting field. Corrosion in one form or another is the greatest enemy of metal parts. In consequence, the efforts of the metallurgical research laboratory have been largely directed towards perfecting the ideal rustless steel. One of the most important of the corrosion-resisting steels is the well-known 18-8 chromium-nickel steel, which is now manufactured under various trade names. This steel is rapidly finding application in many fields where such characteristics as resistance to atmospheric and chemical corrosion are desired. Even more recently there has been developed a series of 18-8 chromium-manganese steels, which contain from 17 to 19 per cent. of chromium, 5 to 10 per cent. of manganese, and small percentages of copper and nickel. By varying the amount of alloying elements it is possible to produce either a grade suitable for the production of castings or one adapted to the manufacture of wrought articles. This steel retains its silvery finish when exposed to the atmosphere, it is extremely resistant to oxidation, and is easily worked. It retains its strength to a remarkable degree at temperatures ranging from 1,375° to 1,650°F., whilst the clean and non-porous castings which it gives are highly resistant to sulphur-bearing gases at elevated temperature, acid mine water, salt water, sulphite liquor, nitric acid, and weak mixtures of nitric and sulphuric acids.

For what might be termed the moderate corrosion and heat-resisting field, there has been developed a 4 to 6 per cent. chromium alloy steel which is intermediate in cost but has many times the life of plain carbon steel when subjected to moderately high temperatures and corrosive conditions. Concrete reinforcing bars of this steel have been used recently in the construction of a hydro-electric power dam giving satis-

factory results. Large quantities have also been used in the construction of stills and condensers at oil refineries. Among other corrosion resisting alloys might be mentioned a nickel-molybdenum-iron which resists the action of hydrochloric acid, and also shows good resistance towards sulphuric and acetic acids; it is reported that this product can be cast, forged or rolled, and is readily welded by the electric arc or by the oxy-acetylene process.

The increased speed of chemical reactions at high temperature and pressure, and the greater efficiency of steam turbines at high pressures, have caused revolutionary changes in the design of oil refinery and power plant apparatus. To keep pace with the demands of these industries it was necessary to develop alloys having a notable degree of strength and resistance to corrosion at elevated temperatures. This has led to extensive research on the limiting creep stress of alloys, which may be defined as the maximum stress that a metal can withstand without stretching more than a predetermined percentage when held at a specified temperature for a specified number of hours. Experience has shown, however, that short-time tensile tests at elevated temperatures are not indicative of actual performance in service, but both the chromium-nickel steels and the high chromium steels are well fitted for high temperature and pressure applications. Another steel which has proved satisfactory for work at high temperature and pressure, especially under corrosive conditions, contains from 4 to 6 per cent. of chromium and small amounts of tungsten or molybdenum. Here long time creep tests and impact tests, indicate that the molybdenum and tungsten impart valuable properties to the metal. Research during the last few years has also resulted in the development of a nitriding steel containing chromium and vanadium. Either the ammonia or the cyanide process for nitriding is applicable, depending upon the desired depth of case, which has excellent wear-resisting properties and often attains a high degree of hardness and yet possesses a greater ductility than the case produced on ordinary nitriding steels.

Until recently, cast iron was of indefinite composition and had uncertain physical properties, but modern rigid specifications have necessitated greatly improved foundry practice. For instance, with the advent of ferro-chromium, ferro-manganese and ferro-silicon in briquet form for cupola use, the final composition and structure of the iron is no longer guess-work, and in consequence, the alloy cast irons produced have better and more consistent physical properties.

Efficiency in Steel Treatment

SOME pointed remarks on the question of efficiency at modern steel works were made by Mr. W. Benton Jones, the chairman of Steel Industries of Great Britain, Ltd., and The United Steel Companies, Ltd., in the course of his address to the shareholders at the joint annual general meeting of the two companies, held in London on November 22. He emphasised the fact that there were steel works in this country which are as modern as any in Europe, and that there are other plants which are not modern but yet still reasonably efficient. Efficiency as applied to manufacture has been well defined as the elimination of waste material, waste effort, loss of time, idle plant and idle capital. The popular idea of efficiency seemed to be the installation of very large and very costly plant units designed to operate with a minimum of labour. This, however, is a fallacy. Unless such plants can operate at full capacity, they are inefficient on the ground of loss of time, idle plant and idle capital, whilst plant which is less elaborate and less costly may be really more efficient if operating more regularly. In this connection it might be mentioned that the heat-treatment equipment at the new Ford Works at Dagenham has several interesting features which can be regarded as good means for attaining efficiency. The high-speed steel hardening furnace is of a type which effectively prevents scaling or oxidation of the work and so eliminates waste. In the normalising furnace the chief interest is centred around economy of operation effected by passing the work through the heating chamber in nickel-chromium steel trucks which move in opposite directions. The hot trucks leaving the heated zone of the furnace give up their heat to the cold trucks moving onwards, thus reducing waste heat to a minimum and economising power consumption.

Nickel in Nitriding Steel

CO-OPERATIVE research has recently been carried out by the Massachusetts Institute of Technology and the development and research department of the International Nickel Co., with a view to particularising the rôle of nickel as an integral element in nitriding steels. In this investigation the evaluation of the various materials has been made with regard to the properties of both "case" and "core." The data obtained for steels covering a wide range show that nickel forms a useful constituent in this type of steel. The chief benefits accruing from the use of nickel are threefold. In the first place there is a distinct strengthening and toughening effect on the nitrided case. Secondly, there is a strengthening and hardening effect on the core, which is thereby rendered more capable of supporting the case under conditions tending to give deformation. Thirdly, there is capacity for developing precipitation-hardening phenomena in steels containing aluminium, the ultimate result being that higher strength and better elastic properties are conferred on the core. Nickel may also be used in varying proportions to control the toughness-hardness-relations of the "case" and "core" and thus widen the range of properties in nitrided materials. The effective use of nickel depends, however, upon its presence in suitable ratio to the other alloying elements which may include

chromium, molybdenum, vanadium, aluminium, etc. This subject has recently received the attention of H. J. French and V. O. Homberg in a paper presented to the American Society for Steel Treating ("Iron Age," October 6, 1932.)

Electro-plating Investigations

THE United States Bureau of Standards is reported to have evolved a theory which may form a basis for practical improvements in chromium plating chiefly in respect of the elimination of "waste" due to ineffective deposition. Uneven "throwing" of the solution on articles when dipped is stated to be the crux of the problem. It has also been found that although plating baths consist principally of chromic acid, a small amount of sulphate is necessary. The beneficial effect of the sulphate is said to be due to the fact that it prevents the formation of an impervious film on the cathode, thus permitting clean deposition of metal. Concurrently with this, certain aspects of nickel plating have also been investigated. Determinations of throwing power, cathode current efficiency and conductivity have been made with two types of electrolyte representative of the relatively low-nickel content baths still operated by many platers (at room temperature), and the high-nickel baths recommended for use at elevated temperature. From the results of these investigations, L. C. Flowers and J. C. Warner (Electrochemical Society Preprint, September 1932) conclude that the throwing power of low and high pH solutions approaches a common limiting value as the current density is increased. A decided improvement in throwing power is obtained when low pH baths are operated at high temperatures, whilst there is practically no change in using baths of high pH value. Little difference is found in throwing power between solutions of high and low nickel content when the pH is high. When, however, the pH is low, an increase in the nickel concentration causes an improvement in the throwing power.

Revival of the Basic Bessemer Process

THE establishment of a new steelworks at Corby, in Northamptonshire, by Stewarts and Lloyds, with whom it is understood the United Steel Companies are associated, is designed to meet the demand for basic Bessemer steel hitherto imported from the Continent. It is generally agreed that if the production of basic Bessemer steel is to be undertaken in this country no more suitable place could be selected than Northamptonshire on account of the type of iron ore available there. The Bessemer process was generally employed in this country until some time before the war, when it was almost completely dropped because the steel produced was not of such consistent quality as that manufactured by the open-hearth process now almost universally employed. The demand for the highest possible quality of materials by British engineers and manufacturers of engineering products was chiefly the cause of the basic Bessemer process being abandoned. It is definitely excluded from many British Standard Specifications, but it is good enough for many purposes and has been imported by the re-rolling trades to the extent of approximately 1,000,000 tons annually for some years past. That is sufficient good reason for a revival of the process in this country.

Corrosion of Metals Effect of Salt Solutions and Sea-Water

AT a joint meeting of the Glasgow and Edinburgh Section of the Society of Chemical Industry with the Institute of Chemistry held at Glasgow on November 25, Dr. G. D. Bengough gave the second section of this year's Jubilee Memorial Lecture, his subject being "The Corrosion of Metals in Salt Solutions and Sea-Water."

Corrosion tests, Dr. Bengough said, are grouped under three main headings—industrial, field and laboratory. Industrial tests are carried out under actual working conditions and entail considerable expense, time and danger due to collapse of the test structure. Field tests are conducted in conditions artificially produced so as to resemble as closely as possible working practice. Such tests have been carried out in various parts of the world by examining the corrosion caused by sea water on bars of metal immersed and partially immersed in sea water for varying periods of time. Laboratory tests are more useful at present in determining the controlling factors in corrosion as in larger scale tests the conditions are much too complex. At the Corrosion of Metals Research Station at Teddington the corrosion of zinc, iron, mild steel and magnesium in solutions of sodium chloride and sea water has been studied over a period of years. The rate of corrosion is followed by measuring the oxygen absorbed and the hydrogen evolved under strictly defined conditions, achieved by

the use of specially designed apparatus. The evolution of hydrogen is a factor which has been overlooked in previous work in this field. The oxygen supply is the important factor under the conditions studied and therefore the corrosion rate in concentrated solutions is less than in dilute since the solubility of oxygen is lower in concentrated solutions.

Sea-water differs in a marked degree from solutions of inorganic salts of similar composition. The sea-water used in these tests was a sample obtained three miles out from Plymouth harbour. The hydrogen evolution caused by metals corroding in sea water is much greater than in salt solutions and this is explained by the presence of organic material, since on removal of this material the hydrogen evolution was practically the same as in salt solution. Barnacles, when they die clinging to the sides of ships, produce local corrosion or pitting due to gases evolved from the decaying organic material. Another difference in corrosion in sea water is that an increase in the oxygen supply does not produce nearly such an increase in corrosion rate as a similar increase does in salt solutions. This effect is probably due to the presence of salts of calcium and magnesium but the problem has not yet been fully investigated.

The third and fourth sections of the Jubilee Memorial Lecture will be delivered in Manchester and Newcastle.

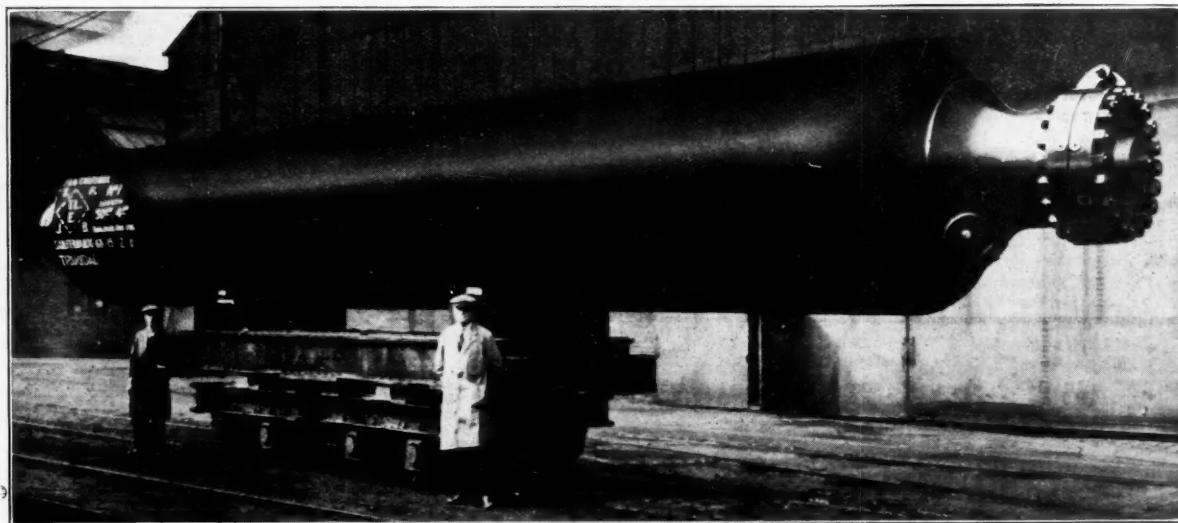
The World's Largest Hollow Forging Reaction Chamber for Cracking Unit

THE firm of Charles Firth and John Brown, Ltd., Sheffield, have just completed the manufacture of the world's largest hollow forged reaction chamber for use with the Dubbs cracking unit owned by Trinidad Leaseholds, Ltd. An undertaking of this character implies very advanced hollow forging technique, and this would only be possible after that prolonged experience in the manufacture of high-pressure boiler drums and similar cracking plants with which the name of the firm is pre-eminently associated.

At the initial stage of the work an ingot of 170 tons was cast at the Atlas Works of the company from three open hearth acid furnaces, and after certain processes under the 6,000 ton forging press, the ingot was taken to the heavy machine shops, where a $25\frac{1}{2}$ in. hole was trepanned through it. The trepanned ingot was then expanded in diameter under the 6,000 ton press, and the drawing process was commenced. During the process the mandrel used, together with the balance weights and the chamber in its rough state, weighted 326 tons. In due course the open-ended forging was put into an 82 in. centre lathe, and then transferred to

a 48 in. lathe with a 70 ft. bed, where it was bored for its entire length. As some indication of the accuracy of the forging operations, it may be mentioned that the finished bore machined to $7\frac{1}{4}$ in. from a forging which measured $69\frac{1}{2}$ in. internal diameter; in other words, only $\frac{1}{8}$ of an inch of material had to be removed.

In the initial forging operations "swells" had been left at each end of the chamber, and these were now closed under the 6,000 ton forging press to the required shape. The next stage consisted of heat treatment in one of the furnaces which have been developed for this class of work. The uniformity of the material in the ingot was demonstrated by the fact that test results taken from bottom and top of extreme ends yielded only a difference of half-a-ton per square inch maximum stress. The final machining in a 50 in. lathe, together with the drilling of 20 bolt holes in each end flange completed the engineering operations. The finished reaction chamber has an overall length just over 48 ft., an outside diameter of $78\frac{1}{4}$ in., inside diameter of $7\frac{1}{4}$ in., and its approximate weight is 66 tons.



The World's largest Hollow Forging ready for despatch from the works of Thomas Firth and John Brown, Ltd., Sheffield

Magnetogorsk—The World's Largest Steel Plant

Progress Under the Five Year Plan

THE heart of the industrial development of Russia, which is the object of the Five Year Plan, is situated in what is known as the Urals-Kusnetz Combiné, which is to represent a capital expenditure of 10,000,000,000 roubles, or about £1,000,000,000 at gold par.

Magnetogorsk, which lies 180 miles on the Asiatic side of the border line between the two continents, is the core of the combine. It is so called after Magnetic Mountain, which consists of 62 per cent. solid magnetic ore. Three years ago this area was a barren waste. There was no town, not even a village. It is now being converted, and successfully, into the world's greatest steel plant, and the industrial capital of the new empire. To-day, for miles round, the land is one huge construction camp. The work is being carried out by the Arthur G. McKee Co., of Cleveland. The original Five Year Plan called for a plant which would produce 650,000 tons of steel a year. After a threat of war with China in 1928, the plant underwent a further development, and it now aims to produce 2,500,000 tons of iron and steel, rising to a capacity of 4,000,000 tons.

At Magnetogorsk, as elsewhere, according to the impressions recorded in a recent issue of "The Industrial Australian," whilst the Five Year Plan is progressing, it is not progressing as rapidly as anticipated. This has been the consequence of the world depression, the inability to provide sufficient credits abroad for the purpose of payment of services and material, and the almost famine conditions which have prevailed in many parts of Russia, and particularly transport trouble, which has been one of the most marked characteristics of the Soviet regime. Shooting the engine-driver, if the train is late, is not conducive to efficiency. The plant to-day is only 50 per cent. of where it should have been if the Plan had marched successfully. It was intended to establish eight blast-furnaces, the largest in the world, each capable of producing 1,000 tons of cast iron a day; 28 open-hearth furnaces, with a capacity of 300 tons of steel a day; 8 coke batteries, each serving a blast-furnace; and 3 "blooming" machines for rolling steel, with the necessary electric power plants, water pumping stations, and other accessory enterprises.

Very Considerable Achievement

It was anticipated that at the end of three years this programme would have been 60 per cent. completed. The actual position at the end of August was that two coke-ovens and two blast-furnaces were functioning, and the foundation was being laid for the first open-hearth furnace. It is not expected now that the plant will be completed until 1935 or 1936, but even so, if the plant is completed by 1940 it will have been a very considerable achievement on the part of the contractors and the Russians. It will be, providing it is operated to capacity, the largest steel plant in the world, and its production will be equal to that of all the Russian iron and steel plants which existed before the war. Ten years, however, cannot be reckoned as an overlong period for the construction of the world's greatest steel plant, situated in a mountainous waste, remote from civilisation, and to which every form of communication, roads and railways, had first to be created.

Magnetogorsk is, therefore, one of the most interesting places in the world to visit and study to-day, if only for the extraordinary contrast between present-day high-speed industrial processes, and the primitive Asiatic background. This contrast is strikingly visible throughout the enterprise. For example, a Nomad Kirghiz from the steppes of Asia can be seen operating the latest high-speed machine that Europe or Asia has produced. The labour forces are drawn from every part of Russia, and from every strata—if Sovietism recognises strata. They are driven not only by the exigencies of life but by a continuous series of "stunts" to increase production.

The second name in the title of the Combine, "Kusnetz," is due to the fact that at Magnetogorsk there is no coal. But 1,500 miles further east, in the heart of Asia, is Kusnetz,

which has enormous coal supplies, in quality equal to the world's best. To bring that coal to Magnetogorsk, a railway has been laid. The trains bring the coal westward, and carry back pig-iron and iron-ore to Kusnetz, where a second steel plant is being erected with an estimated capacity of 1,000,000 tons yearly. In this way, not only will the 300,000,000 tons of magnetic ore be more intensely exploited, but the costliness of one-way traffic upon the railway will be evaded. Apart from iron, steel, and coal, the production of the Combiné will include copper, nitrates, sulphuric acid, potash, and phosphates.

Not the least interesting feature of Magnetogorsk is the socialistic city, built of bricks and concrete, with its wide streets, its workers' dwellings, its parks, its hospitals, lecture halls, and other institutions, elaborately laid out according to the latest ideas in town planning as practised in Germany. This portion of the Plan is not so far advanced, except in rough outlines, as the industrial side, which has been given preference in regard to labour, and also in regard to money. Magnetogorsk is progressing more slowly than anticipated, with more difficulties than expected, but of all the schemes, included in the Five Year Plan, the construction of this giant steel plant seems to be the greatest.

Sponge Iron for Steel Making

Production Contemplated in Canada

DURING the past two years research has been carried out by the Dominion Department of Mines at Ottawa on magnetite iron ore mined at Tenada Island, off the coast of British Columbia. Experiments have shown that sponge iron can be produced from these ores, and it is suggested that large scale operation would probably be successful. Samples of the ore have been despatched to Eastern Canada in order to test the suitability of the material to manufacturers of high-grade steels. Two reports have now been received, and they state that the ore is eminently suitable for the manufacture of sponge iron, which, in turn, has been shown to be suited for the manufacture of steels of low sulphur and phosphorus content.

British Galvanised Steel

A Supplementary Agreement with India

FURTHER details are now available concerning the supplementary agreement made between British and Indian galvanized steel sheet manufacturers since the close of the Ottawa Conference, when discussions began. This agreement provides for the imposition of the following duties in India:—Rs.30 per ton on United Kingdom sheets made from Indian semi-finished material; Rs.53 per ton on United Kingdom sheets made from any other semi-finished material; Rs.83 per ton on foreign sheets. The principal parties to the agreement, it is understood, are the Tata Iron and Steel Co., of Jamshedpur, India, and Mr. James Whitby, of the Oriental Steel Co. and chairman of the Iron and Steel Exchange, London, who is acting on behalf of British exporters. The Tata Company, it is expected, will manufacture galvanized steel sheets for the portions of the Indian market in the most economical to supply, leaving the remainder to be supplied by British firms acting through Mr. Whitby.

Two years ago British exporters were supplying 300,000 tons of galvanized steel sheets a year to the Indian market, the normal requirements of which were increasing by about 10,000 tons annually. To-day, owing to the general trade slump, imports into India are only about one-third of the former total, but it is believed that, on ratification of the agreement by the Indian Legislature, the preferential duty will enable British exporters to supply all India's imports, including about 75,000 tons now shipped in Belgium.

Iron Company's Reorganisation

Drastic Scheme Proposed

ACTING on the advice of the advisory committee, the directors of Pease and Partners, Ltd., have drawn up a new scheme of arrangement designed to place the company in a position to take full advantage of better conditions as and when they develop. This scheme provides for the reduction of the ordinary share capital from £3,000,000 to £1,500,000, but holders of these shares are to retain only £150,000, the balance of £1,350,000 being surrendered. In other words, their shares are to be reduced from a nominal value of £1 each to 1s. The 5 per cent. debenture stockholders are asked to surrender 30 per cent. of their stock for cancellation, and as compensation they will receive out of the shares surrendered £40 in fully-paid shares for each £30 of stock given up. Interest arrears are to be wiped out, and further payments, which will be non-cumulative, will not be made until March, 1938, and then only if available profits permit. Unsecured creditors coming within the scope of the scheme waive accrued interest on the amounts owing to them, and in satisfaction of their claims will receive credit notes of a nominal value of 70 per cent. and fully paid shares for the balance of 30 per cent. These credit notes will carry non-cumulative interest at the rate of 4 per cent. per annum, ranking after the 5 per cent. debenture stock, but no payment is to be made until after March, 1938.

In framing their proposals the directors have done their best to treat each class of security holder fairly. Shareholders, naturally, are called upon to make the biggest sacrifice; but apart from the 4 per cent. debenture stock, which is irredeemable and carries a first floating charge on the undertaking of the company, holders of all classes of securities are called upon to make some contribution. The scheme is unanimously approved by the Advisory Committee, who strongly recommend its acceptance. In the event of stockholders refusing their sanction, serious consequences may follow, as the Advisory Committee have informed the company that unless the whole financial structure is reorganised on lines which when trade revives should afford a permanent solution of the principal difficulties, they must exercise their right to bring the moratorium to an end. In that case it will be impossible to avoid the appointment of a receiver and the liquidation of the company. On the other hand, if the scheme is approved a trading profit may be expected even under present conditions, and the company will once more be placed on an economic footing.

Metal Spraying Demonstration

Distortion by Heat Avoided

METAL spraying from a pistol small enough to be held in one hand and capable of being put to an infinite number of uses, either for protective or decorative purposes, claimed the attention of industrialists, metallurgists and public officials assembled at a demonstration at the work of Metallisation (Ltd.), at Dudley, on November 28.

The metallisation process, by which aluminium, zinc, copper and other metals can be sprayed on to all kinds of surfaces, is not a new process, but one which is claimed to have been perfected by the company now exploiting its possibilities for the use of industry as its simple and effective service becomes known to the commercial community. It is a process by which any metal or alloy capable of being drawn into wire and of being melted in any oxy-coal gas, oxy-hydrogen or oxy-acetylene flame, is deposited by means of a special pistol on metal, wood, fabric or any other surface. The pistol is fed from the coil of wire of the metal being sprayed, and is automatically pushed through the pistol by compressed air and projected in the form of the metal spray on to the substance required to be coated. Although the wire is melted in the pistol at very high temperature, the enveloping blast of compressed air has an almost instantaneous cooling effect, so that it is possible to hold the hand in the metal spray a few inches away from the pistol nozzle without discomfort. Those who witnessed the demonstration were able to test this freely for themselves. This cold process has the great advantage of eliminating distortion caused by heat in other methods; other detrimental effects of heat are also avoided. Comparatively

fragile materials such as celluloid, wood, rubber and cloth can be sprayed without damage.

A wide variety of processes were demonstrated, and subsequently the company were entertained to lunch at the Grand Hotel, Birmingham, where they were welcomed by Sir Martin Melvin, a director of Metallisation (Ltd.).

Sir GILBERT VYLE, who proposed a vote of thanks to the company for its hospitality and expressed wishes for the success of the venture, said the metal-spraying business was more than a local adventure. It would be doing a national service in the prevention of waste by way of rust and corrosion. There had been many ways of combating rust, and now came this newer process in which a great element of its success was simplicity in operation. Metallisation had been perfected in technique, and what was now needed was its commercialisation.

Valves for the Chemical Industry

Use of a New Alloy Cast Iron

A CONSTANT potential source of trouble in valves used in the chemical and allied industries is due to the accelerated corrosion which is liable to occur at points where the flow or corrosive fluids is checked or impeded. Since the utmost reliability in service is demanded of such valves, it is essential that the greatest care be exercised in the choice of metal from which they are to be constructed, so that the corrosive attack may be reduced to a minimum.

For the handling of strongly corrosive liquids, materials such as pure nickel, monel metal and the corrosion-resisting steels are available, but there are certain applications in which the rate of attack is less severe and the use of these comparatively expensive materials is not justified. Under these circumstances cast iron is commonly employed, with brass or bronze as alternatives where a superior metal is required. Recent developments in the field of alloy cast irons have led to the adoption of the new austenitic types of iron, which are produced by the addition of large proportions of nickel or nickel and copper. About 20 per cent. of these elements is generally present, while up to 5 per cent. of chromium is also frequently added to improve hardness and strength. Such irons are manufactured under the name of "Ni-Resist."

The superior corrosion-resistance of Ni-Resist, coupled with other advantages as good casting properties and ready machinability, is bringing it rapidly into favour for many applications in chemical engineering, including valves of various types. The alloy is specially resistant to attacks by caustic solutions and also to weak sulphuric acid. This characteristic renders it suitable not only for a large number of applications in chemical industries, such, for example as occur in the preparation of caustic, but also offers a cheap solution of many corrosion problems met with in other branches of engineering. In the paper industry and in textile manufacture, for instance, Ni-Resist is of particular interest on account of its resistance to many process liquors. In the handling of crude oil, for instance, the presence of sulphuric acid is a constant source of corrosion troubles, and Ni-Resist valves have been found to outlast those of ordinary cast iron by many times, the actual life of the special castings frequently being much superior even to those of brass and bronze. The alloy is at the same time cheap, castings generally being available at prices lower than the common non-ferrous alloys mentioned.

The standard Ni-Resist usually contains 14 per cent. of nickel and 7 per cent. of copper, but in some applications the presence of copper is undesirable, and an alloy containing 20 per cent. of nickel alone is then adopted. For conditions where a still better resistance to corrosion is required alloys with higher additions of nickel and chromium (e.g., nickel 30, chromium 16, per cent.) are available.

Iron and Steel Trade Relations with Scandinavia

BRITISH representatives of the iron and steel trade, who are to discuss the possibilities of closer relations between Great Britain and Sweden in the iron and steel trade, arrived at Stockholm on November 27. They are meeting the leading Swedish industrialists and visit their plants, and will then proceed to Norway.

Some Recent Metallurgical Patents

Protection of Magnesium Alloys

To protect magnesium or magnesium alloys against corrosion the metal can be immersed in or rubbed or sprayed with a solution of selenious acid or a solution of a soluble selenite containing one or both of (a) selenious acid and (b) an acid or salt which corrodes the metal, *e.g.*, sodium chloride. Examples of solutions containing a soluble selenite include a solution of sodium selenite and phosphoric acid; a solution of sodium selenite, selenious acid, and sodium chloride. A solution containing sodium selenite and hydrochloric acid is referred to in the provisional specification. It is stated that a coating containing selenium in the elemental or combined form is deposited on the metal. The protective action may be improved by heating the coated metal to 170-225° C. The coating forms a good basis for paints. (See Specification No. 378,916, of G. D. Bengough and L. Whitby.)

Use of Boron in Alloys

AN alloy for tools, etc., can be composed of a preponderant proportion of a boride of a refractory metal such as tantalum, niobium or vanadium and an auxiliary metal of the iron group. In making the alloy boron and the refractory metal in just sufficient or in slight excess of the quantity required to combine with the boron, after a thorough mixing in a ball mill, are placed in a tantalum crucible surrounded by tantalum powder inside a graphite crucible and heated in an evacuated electric furnace. The boride is ground and after degasification by heating *in vacuo* in an electric furnace is thoroughly mixed with a hydrogen reduced auxiliary metal, shaped under great pressure and finally heated *in vacuo*. All traces of embrittling gases are removed from the alloy by heating each of the components to a degasification temperature *in vacuo* before or after mixing with the other components. (See Specification No. 379,681, of Fansteel Products Co., Inc.)

Extracting Metals

SULPHIDES of non-volatile metals (*e.g.*, iron, nickel, molybdenum, cobalt, and copper) can be reduced to metallic form by heating them without fusion with one or more oxides or oxide compounds or other compounds such as carbides, but excluding sulphides, of calcium, magnesium, or barium. The heating may be carried out in the presence of one or more solid, liquid, or gaseous reducing agents, and mixtures of reducing agents such as hydrogen and coke may be used, the liquid or gaseous reducing agents being blown into the furnace, preferably a rotary one, through a pipe. The oxides, etc., of calcium, etc., are used in an amount which is larger than that equivalent to the amount of sulphur to be removed, and the oxide compounds other than oxides may comprise carbonates, hydroxides, or organic salts such as acetates and oxalates. The metal is separated from the sulphur-binding material by treatment with a solvent or by magnetic separation. (See Specification No. 379,331, of A. A. Johnson, B. M. S. Kalling and C. von Delwig.)

Extraction of Nickel

SOLUTIONS containing nickel, and also copper and iron, can be treated with a metallic powder containing nickel to cement the copper, and then aerated to precipitate ferric hydroxide. Preferably, a low-temperature, gas-reduced nickeliferous powder is used, but reductions may be effected by charcoal. In an application of the process, pulverised nickel-bearing materials such as Bessemer mattes or nickel bottoms produced by the Orford process are desulphurised by roasting, and may then be leached with acid to remove copper. The residue is divided into major and minor portions. The minor part is ground and reduced to nickeliferous powder, at 300 to 500° C., for example, by water gas. The major part is reduced with coke, coal, or charcoal at 1,500 to 1,550° C. to form nickel anodes, which are placed in the anode compartment of an electrolytic cell. The impure electrolyte is removed from the anode compartment, heated, say, to 55° C., and treated with the nickeliferous powder produced from the minor portion. After separation of the cemented copper, ferric hydroxide is precipitated by air, and separated. (See Specification No. 379,322, of The International Nickel Co., Inc.)

Non-Porous Metal Castings

NON-POROUS metal castings can be produced from alloys containing magnesium by introducing hydride, for example, hydride of silicon, boron, zirconium or antimony, together with hydrogen into the molten metal. A flux, such as magnesium fluoride, may also be added to the bath. (See Specification No. 377,679, of E. Strasser.)

Chromium Steel

IN manufacturing chromium steel by the Thomas process the blowing can be interrupted at a point short of normal dephosphorisation while the steel still contains at least 0.80 per cent. of phosphorus, whereupon chromium or a chromium alloy is added in the convertor and the bath is further blown for a very short period to thoroughly mix the melt. (See Specification No. 379,590, of Vereinigte Stahlwerke A.-G.) The process can be modified by blowing in the convertor crude iron already containing chromium which is produced from ores containing chromium; or by deoxidising the steel after interrupting the blowing when the steel contains at least 0.08 per cent. of phosphorus, preferably by ferro-manganese, then adding the chromium or chromium alloy and allowing the bath to stand for a period. (See Specification No. 379,598.)

Production of Wrought Iron

IN producing wrought iron, steel scrap, cast iron scrap, or a mixture of the two having an average carbon content not exceeding 2.5 per cent., a manganese content of not over 0.90 and a silicon content of not over 1.00 is melted in a cupola furnace and a portion of the tapped-off molten metal is heated in a rotary puddling furnace containing an oxidising agent and puddled, the agglomerated mass resulting from the puddling operation being removed, squeezed and rolled. If a mixture of steel scrap and iron scrap is used, the proportions of the materials are such that molten metal containing 3.5 per cent. of carbon, 0.35 of manganese, 0.40 of silicon, 0.50 of phosphorus, and 0.10 of sulphur is produced and the wrought iron resulting from the puddling of such metal contains 0.021 per cent. of carbon, 0.028 of manganese, 0.098 of silicon, 0.060 of phosphorus, and 0.037 of sulphur. (See Specification No. 378,891, of The Highland Iron and Steel Co.)

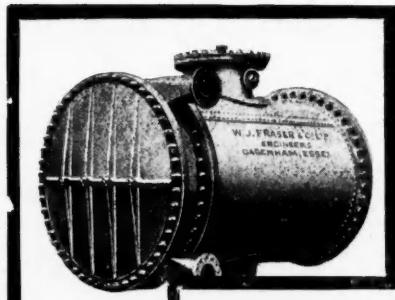
Cyanide Cementation Baths

IN maintaining the activity of cyanide cementation baths, the alkalies or alkaline-reacting substances, which are formed by the decomposition of the cyanides and which hinder the cementation process, can be rendered innocuous by being converted into non-alkaline or less alkaline substances by the periodic or gradual addition, during the process, to the melt bath of salts other than cyanides (*e.g.*, chlorides) of elements the cyanides of which decompose more readily than the cyanides already present in the bath, the cations of these salts being less electropositive than those of salts already present. The salts may also be added in conjunction with the fresh supplies of cementing substances when replenishing the bath, the composition of the mixture being so selected that it contains sufficient cyanide to produce the original cyanide content of the bath and also a sufficient quantity of the salts to produce the same conditions as at the commencement of the process. (See Specification No. 379,752, of Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler.)

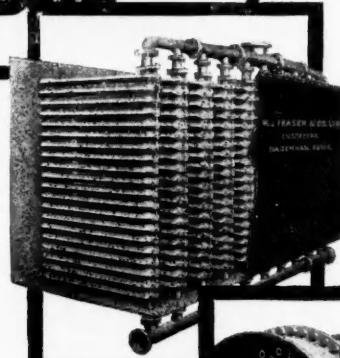
An Improved Aluminium Alloy

A COMPANY known as the Ayedeece Metals Parent Co., Ltd., is in process of registration with a capital of £15,000 to exploit a new patent for the manufacture of aluminium alloy, which is claimed to be a great improvement on any other alloy at present on the market. Preparations for its manufacture have already been made on the site of the old Cyfarthfa Iron-works at Merthyr Tydfil, where buildings have been placed at the free disposal of the promoters for a period of at least three years. Two furnaces for experimental purposes have been completed and operations have begun, in charge of Mr. A. J. Wakelin, one of the patentees.

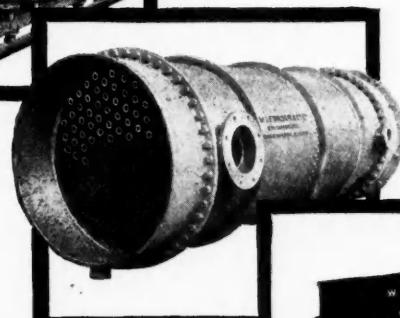
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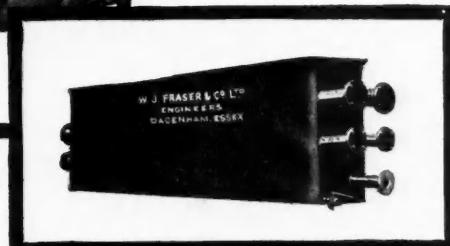
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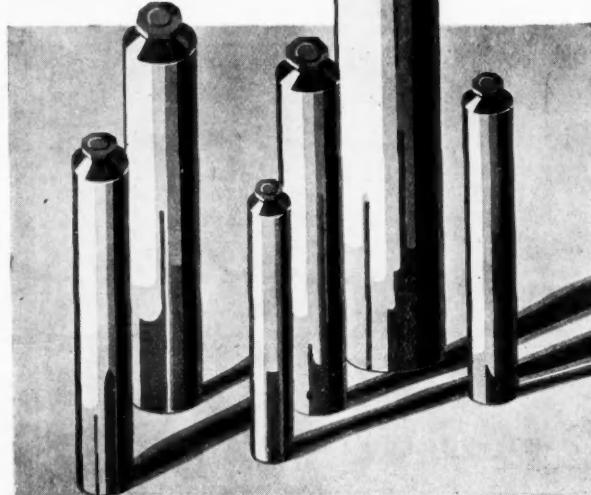
INDEX TO ADVERTISERS

Ordinary numerals before names of firms show page numbers of advertisements in "The Chemical Age Year Book" for 1932

Albright & Wilson, Ltd.	130 Feltham, W. H. & Son Cover iii	14 & 15 Page (Chas.) & Co., Ltd. viii
47 Aluminum (II), Ltd.	18 & 19 Follows & Bate, Ltd. xxix	70 Paterson Engineering Co., Ltd.
Aluminum Plants and Vessel Co. Ltd.	100 Farnham Spraying Machine Co.	Perry & Hope, Ltd. xxiii
Appleton & Howard, Ltd.	Foye (W. & G.)	Piggott (Thos.) & Co., Ltd. Cover iii
Armeo International Corporation	Fraser (W. J.) & Co., Ltd.	Pitman (Sir Isaac) & Sons, Ltd.
30 Ashworth, Oliver & Co.	Fulserite	132 Potter (F. W.) & Soar, Ltd. xii
Association of British Chemical Manufacturers		Power Gas Corporation, Ltd.
30 Ashworth, Oliver & Co.		Premier Filterpress Co., Ltd. xxiv
Association of British Chemical Manufacturers		56 & 104 Price, Stutfield & Co., Ltd. Front Cover
30 Ashworth, Oliver & Co.		
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Back of Diary Dexine, Ltd.		Articles for Sale or Wanted
190 Dickinson, John (Bolton), Ltd.		Business for Sale
37-48-49 Dorr-Oliver Company, Ltd.		Companies' Notices
Doulton & Co., Ltd.		Contracts
Duxbury (Thomas), & Co.		Educational
181 Edwards, W., & Co.		Financial
29 Emco Dyestuffs, Ltd.		Official Notice
Enamelled Metal Products Corporation, Ltd.		Patents for Development
126 Evans, Adlard & Co., Ltd.		Sales by Auction
Evans, T. E., & Co., Ltd.		Stocks and Shares
		Public Notice

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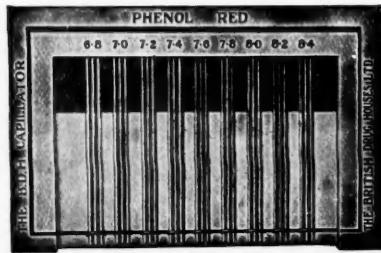
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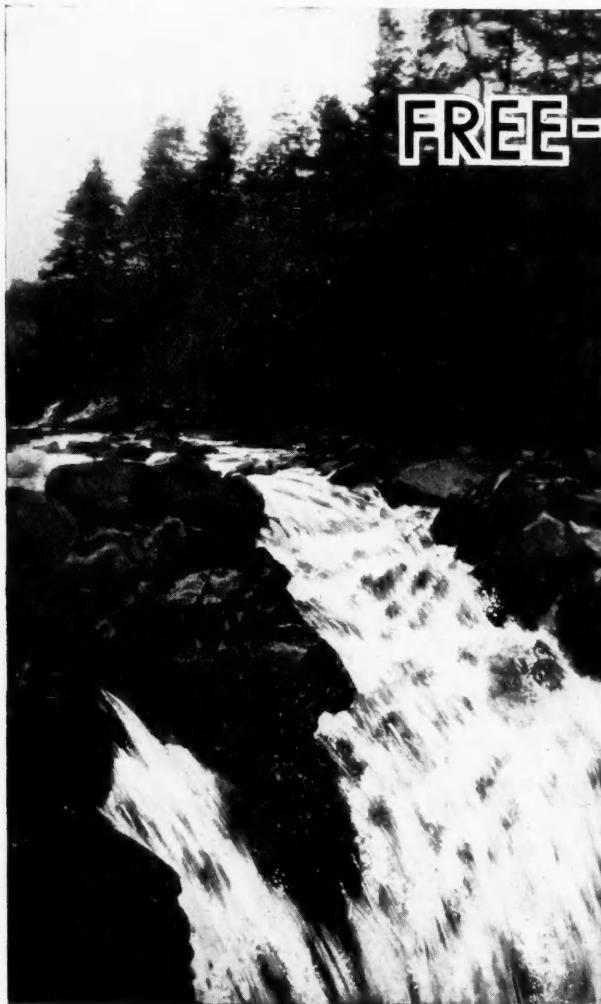
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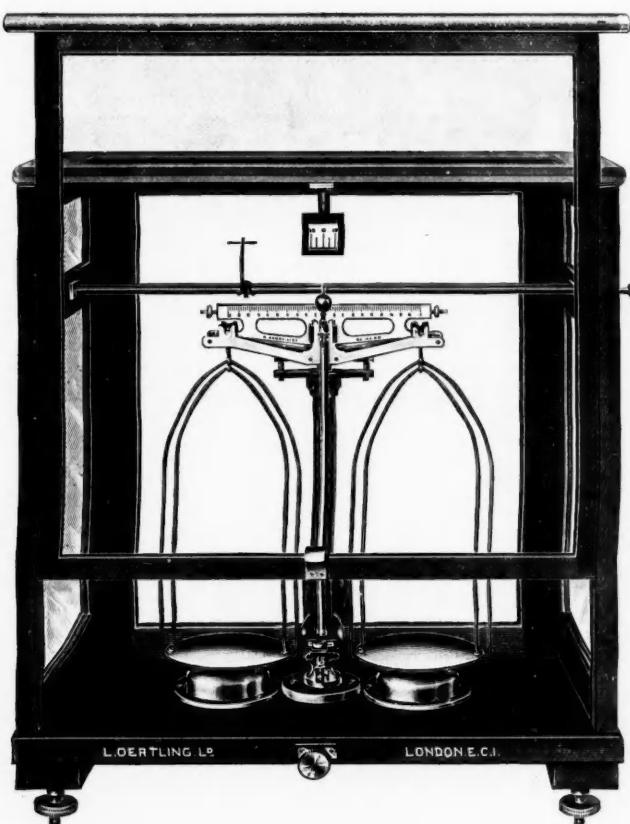
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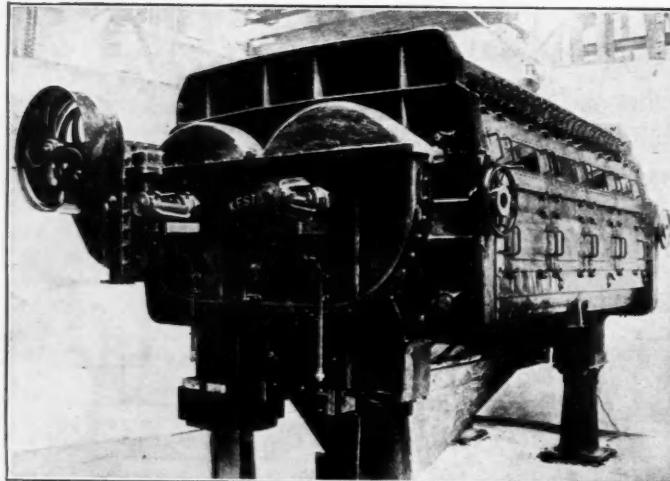
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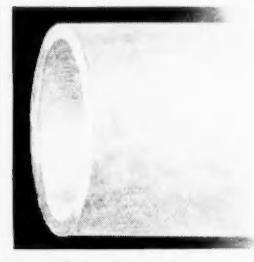
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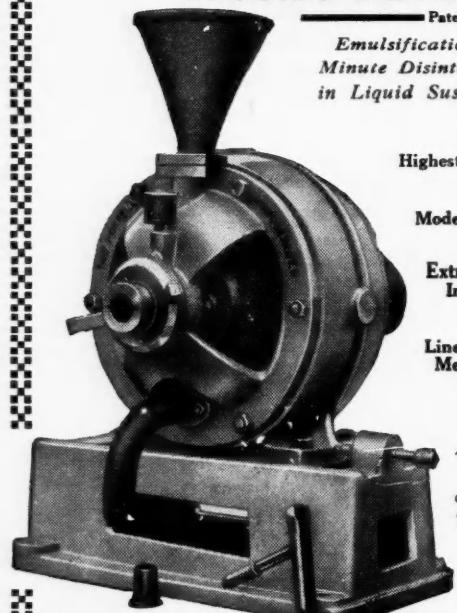
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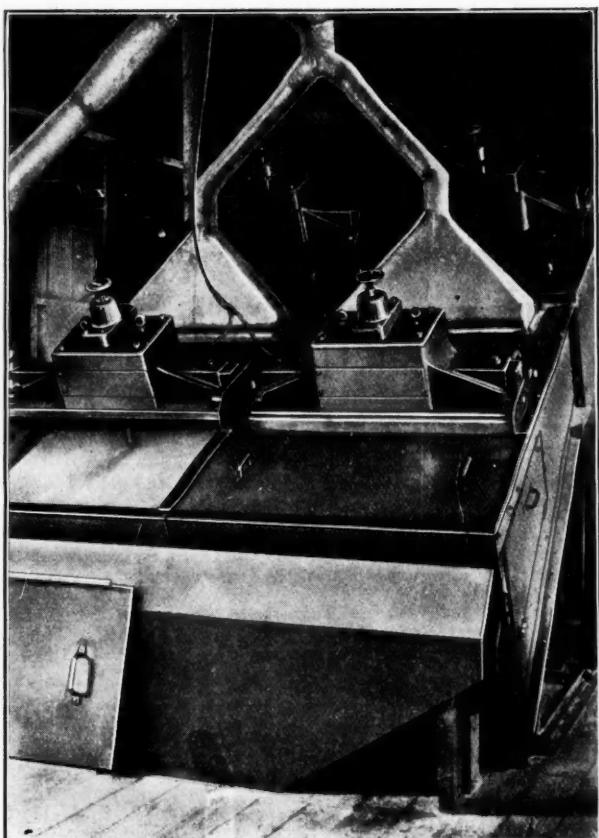
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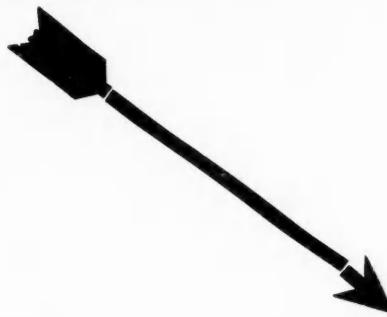
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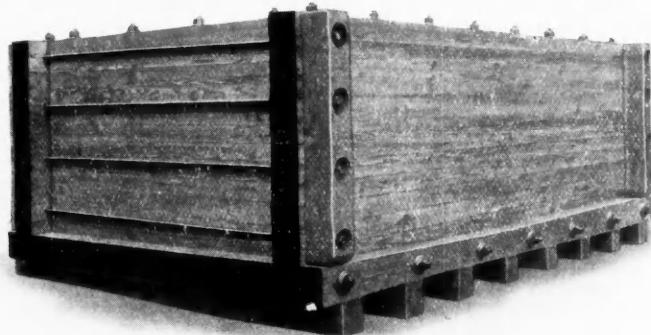
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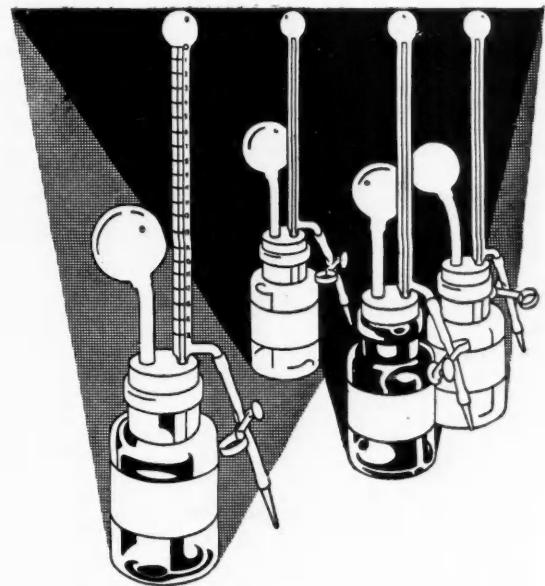
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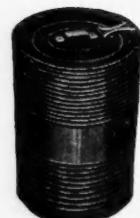
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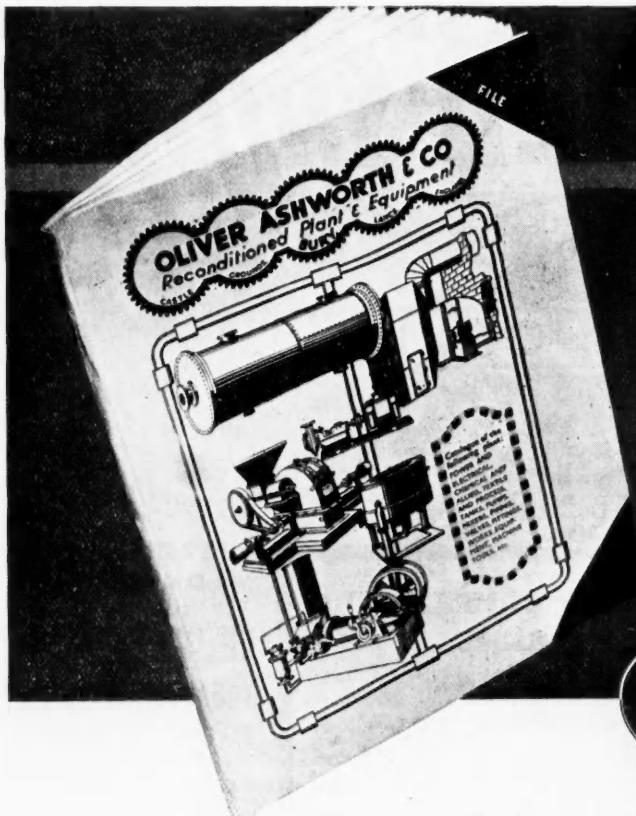
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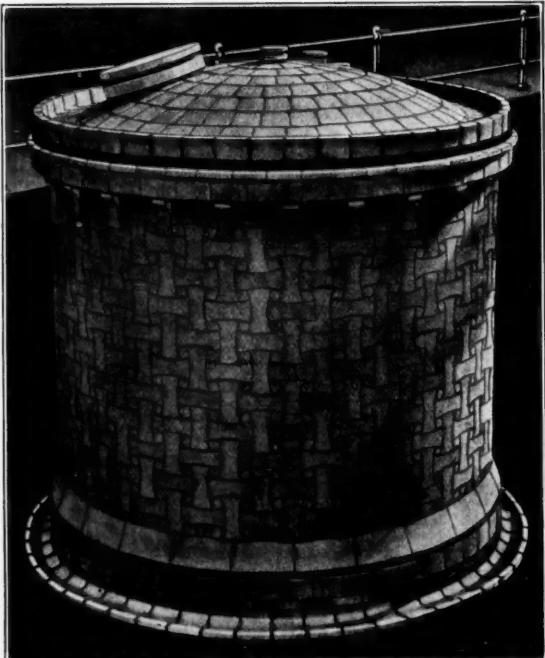
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CONTENTS

EDITORIAL.

The Chemical Industry in 1932 615-616

FEATURES.

Some Thoughts on 1932. By Professor H. E. Armstrong 617-618

The Ceramic Society—Papers Presented during the Year 618

Chemical Engineering Progress during the Year. By A. J. V. Underwood, D.Sc., M.I.Chem.E. 619-620

Conditions in the Heavy Chemical Industry. By P. Parrish, F.I.C., M.I.Chem.E. 621-623

The Institute of Chemistry 623

Recent Progress in Fine Chemicals. By Dr. F. H. Carr 624-625

The Institution of Chemical Engineers 625

A Review of the Solvents Industry in 1932. Hopes for a Wider Use of Lacquers 626-627

The Chemical Society Widens in Scope—Developments During the Year 627

Financial Position of the Chemical Industry. By S. Howard Withey, F.C.I. 628

New Prospects for Low Temperature Tars—Synthetic Ammonia for Fertiliser Manufacture 629

Developments in Plastics. By H. V. Potter, B.Sc., F.I.C. 630-631

Federal Council for Chemistry 631

The Nitrogen Industry in 1932. By E. B. Maxted, D.Sc., Ph.D., F.I.C. 632-633

Oil and Colour Chemists' Association 633

The Department of Scientific and Industrial Research—Chemical Research in 1932 634-635

Ottawa and After from the Chemical Point of View. By Dr. E. F. Armstrong 636-637

The British Association of Chemists—Expanding Activities and Membership 638

The British Colour Council 638

Manufacture of Solvents from Corn Starch—Wider Utilisation of Vegetable Products 639

Progress in Chemical Standardisation—What the British Standards Institution has Achieved—The Biochemical Society—Society of Dyers and Colourists 640

How Manufacturers Have Served the Industry in 1932—New Developments in Plant and Products 641-648

Edible Fat and Oil Control 649

From Week to Week 649-650

The Year's Market Conditions 650

Forthcoming Events 650

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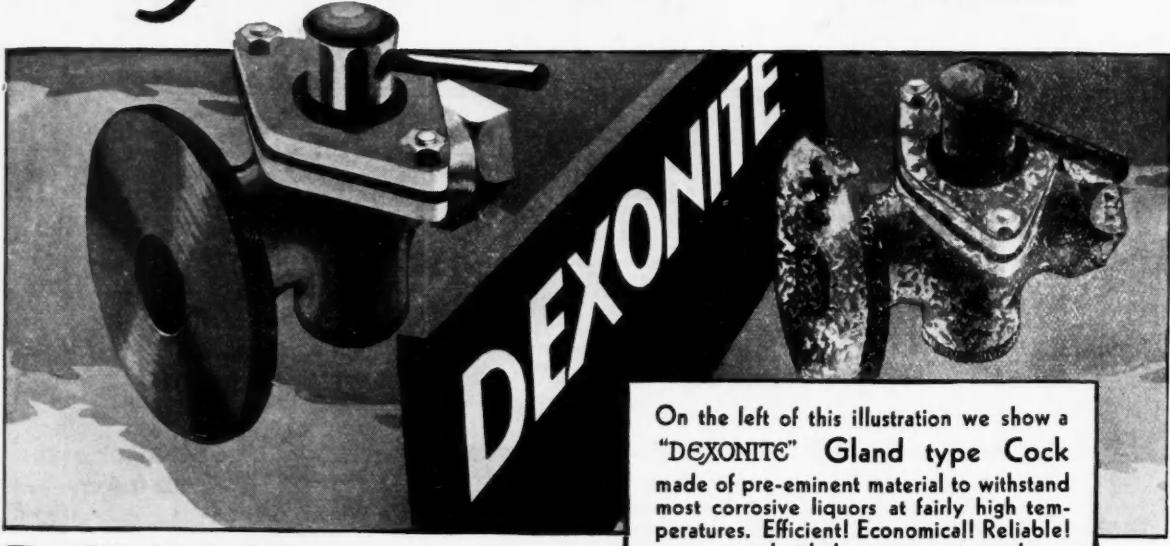
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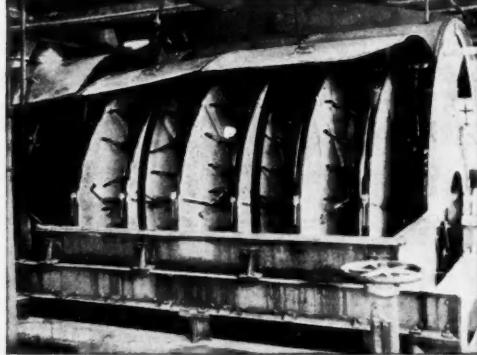
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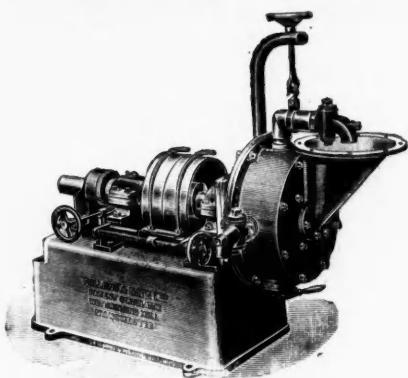


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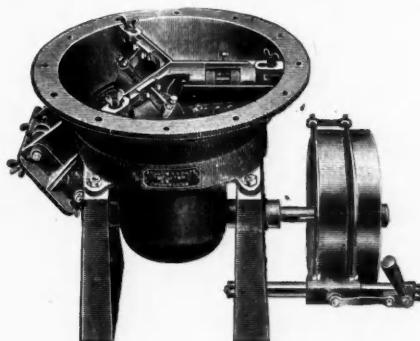
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